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INTRODUCTION.

It has been decided to limit this Report considerably in view of the necessity for economy under present conditions. On that account the usual statistics relating to the analyses of vintage fruit for the season 1915-16, the dates of blossoming of fruit trees, and the crop records from the variety trials of fruit, have been omitted, while the results of the work on stock influence upon vintage quality and other characters of apples and on other problems still incompletely investigated have also been withheld. It is hoped to publish this information in a later report.

No attempt has been made during the year to complete the building scheme at the Station. The only development in that direction has been the conversion of the old washing shed in the original cider premises into a press room for cider making. In this a new hydraulic press has been installed.

Owing to his detention in Germany Dr. A. E. Lechmere, M.Sc., whose appointment as mycologist was referred to in the last Annual Report, has not yet been able to take up his duties.

Mr. John Ettle, who has been connected with the National Fruit and Cider Institute since its establishment, first as Superintendent of the Fruit Department and later, since its association with the University of Bristol, as Honorary Adviser in Practical Horticulture, has now vacated the latter position owing to the termination of his appointment as Horticultural Instructor under the Somerset County Council. The Institute is under a deep obligation to the latter body for placing Mr. Ettle's services at the disposal of the Institute during this period. It is also desired to record an acknowledgment and appreciation of Mr. Ettle's valuable assistance, which was particularly helpful in the earlier years when the staff was limited.

Mr. S. P. Wiltshire, M.Sc., Research Scholar of the Board of Agriculture and Fisheries, was engaged in the continuation of his investigations on Apple Scab and Apple Canker at the Station during the summer of 1915.

As anticipated, the work of the Station has been rendered difficult owing to the number of the staff engaged on military service. Since the beginning of the war eleven members of the staff have

joined the Army, and the only men of military age who are now working at the Station are those holding positions of responsibility and are on that account indispensable. These have attested under Lord Derby's scheme. The shortage of labour has, to some extent, been met by the employment of women.

The whole of the land now owned or leased at the Station has been fully planted. Consequently there have been no developments of importance during the past year in the direction of formation of new plantations. The severe hailstorm of July 4th, 1915, unfortunately caused very serious damage. The crops of small fruits, plums, and apples were practically ruined and the pear crop also suffered seriously, although to a less degree. The trees, especially the younger ones and the young growths on the older trees, were badly damaged, young shoots being cut off and the older stems and branches severely bruised, and, in many cases, cut open so badly as to expose the wood. It is feared that this may seriously affect much of the experimental cultural work for which they are being used.

The work on fruit breeding has been continued actively, and a large number of new seedlings have been raised. The first results of the strawberry crossing experiments have now been obtained, and sufficient information will probably be available for a preliminary account of this work to be included in next year's Report.

A fair number of standard trees of cider apples and perry pears were available for distribution in the autumn of 1915, but, owing to labour difficulties and the expense of planting, it was not found possible to dispose of the whole of them. Altogether 438 trees were sent out. The particulars of the new trial orchards established will be found in the section of the Report relating to Trial Cider and Perry Orchards.

As in the previous year, the Staff of the Department has co-operated with the Agricultural Organisers of the Counties of the Bristol Province in carrying out a series of joint field demonstrations. The demonstrations arranged were concerned with the manuring of grass land and trials of certain varieties of wheat and of mangels. In connection with the latter Mr. Gimingham has analysed samples of the mangels grown at the respective centres for the purpose of comparison of their composition and feeding value. His results are included in this Report.

During the year the attention of the staff has been given to a number of investigations which have called for attention owing to the existing war conditions. A number of questions have been referred to the Station in connection with the work on the preservation of fruit and vegetables which is being carried on under the auspices of the Board of Agriculture and Fisheries at experimental

factories at Broom Junction and Dunnington Heath. Methods for the utilization of pressed cider apple pomace have been studied, in view of the considerable quantities of this useful bye-product which are available every season. Further attention has been given to the method of making apple jelly from cider fruit without the use of sugar. Judging from the many requests for information in connection with the making of this article which have been received, it has aroused considerable interest. The results of the investigations which have been carried on since the establishment of the Institute on the disorders of cider and perry have been summarized and published in the "Journal of the Board of Agriculture," and it is hoped that the very considerable loss which occurs each year may be reduced by the methods of treatment recommended. Reference was made in last year's Report to the work in progress on the waste of saw-mills as a source of potash.

Also arising out of the war, a demonstration of Belgian methods of intensive culture of vegetables is being carried on at the Station. This work is in charge of M. Savoye, a Belgian expert. The demonstration was started early in June, 1915, a date too late to allow of any decision being formed as to the suitability of such methods in this country. The work also suffered severely owing to damage by the hailstorm referred to above. It is therefore being continued during 1916, and it should then be possible to form a better idea as to the merits of the system as applied to English conditions.

In September, 1915, the Station was visited by a deputation sent officially by the French Department of Agriculture to investigate the conditions of cider-making and cider fruit culture in this country, and to endeavour to find a market for French vintage apples which could not be utilised in that country owing to the war. A tour of the party through representative cider districts in the West of England was organised under the charge of Mr. Grove, and some of the largest cider factories were also visited.

Acknowledgment must be made of the very useful assistance which has been given in the experimental work by Messrs. E. P. West, W. Camps and J. Coombes. Mr. West, as last season, undertook the charge of the practical work in the cider house in the absence of the regular cider-maker on military service. Mr. Camps, the head laboratory assistant, has helped very considerably with the research work in the laboratory, and the experiments on the bottling of fruit and vegetables and on the pectins of cider apples have mainly been made by him. Mr. Coombes has had a difficult task in conducting the cultural experiments in the fruit plantation owing to the shortage of labour, and the records which are normally kept have had to be reduced somewhat on that account.

The following is a list of publications by the staff of the Department in 1915 :—

“Annual Report of the Department for 1914.”

“Report of the Work of the National Fruit and Cider Institute for 1914” (*Journal of the Bath and West and Southern Counties Society*. Fifth series. Vol. IX).

C. T. Gimingham, “Some West Country Soils” (*Journal of the Bath and West and Southern Counties Society*. Fifth series. Vol. IX).

C. T. Gimingham, “A Note on the Waste from Saw Mills as a Source of Potash” (*Journal of the Board of Agriculture*, 1915. Vol. XXII).

A. H. Lees, “Winter Cover Washes” (*Annals of Applied Biology*. Vol. I., Nos. 3 and 4).

S. P. Wiltshire, “Infection and Immunity. Studies on the Apple and Pear Scab Fungi (*Venturia inaequalis* and *V. pirini*)” (*Annals of Applied Biology*. Vol. I., Nos. 3 and 4).

SINGLE VARIETY CIDERS AND PERRIES, 1914-15.

BY B. T. P. BARKER AND OTTO GROVE.

During the season 1914-15 a large number of single variety ciders and perries were made, the details of which are appended. The apple crop of 1914 was a very abundant one, and upon the whole it can be said that the fruits were well developed and ripened. Consequently the ciders were mostly of a good quality. The specific gravities of the juices averaged 1.0532, which is about normal. The percentages of acid and tannin were in many cases above the normal, which gave the ciders a well-marked flavour and aroma. Indeed, in several instances, the tannin character was unduly pronounced. While the percentage of acid showed a tendency to be above the normal, particularly for the sweet and bitter-sweet varieties, in the case of the sharpest varieties it was somewhat lower than usual. As usual some of the best ciders of the season were made from the Kingston Black juices, that from Norton Fitzwarren being generally considered the best: but none could be considered quite typical or up to the standard of the variety. Several of the Cap of Liberty ciders were remarkably good, this being especially the case with that from South Petherton. Several new French varieties, grown in Somerset, were tried, and some of them gave promise of being of value; but the quantities of fruit available were not quite large enough to make the test a completely satisfactory one.

Generally speaking, the 1914-15 vintage may be regarded as well up to the average, occasional ciders being exceptionally good. It was not, however, quite so good for varieties which normally do not require blending, the tannin character being too marked and a lack of fruitiness noticeable.

Where the quantity of fruit of the varieties tested was sufficient, a number of experiments were carried on with the juices. These experiments were designed to show the effect of (a) fermentation with selected yeasts as compared with natural fermentation, (b) the fineness of the grinding of the pomace, (c) using the fruit in unripe, ripe, and over-ripe condition, and (d) the checking of fermentation by racking only as compared with filtration.

(a) The trials of fermenting the juice with selected yeasts were carried out in a similar manner to those made in previous years. Altogether 13 different kinds of yeasts were tested. The results did not show in any case a pronounced superiority in the cider as a result of fermentation with the selected yeasts, natural fermentation giving in all cases ciders almost equally good or sometimes slightly superior. Generally the selected wine and cider yeasts gave a slightly superior product which tended to be somewhat brisker and more delicate in character than that from natural fermentation. The results with pressed yeast, however, were markedly inferior to those of natural fermentation, and it is clear that pressed yeast cannot be used with advantage in cider work. In view of the comparatively small variations between the results with the other selected yeasts and natural fermentation, it seems probable that the former do not find in apple juice fermented under ordinary circumstances the conditions necessary for vigorous growth and the development of their special characteristics; and there is reason to think that the low temperature at which cider is fermented in the ordinary way is largely responsible. Further trials to be carried out at a higher temperature are therefore being arranged.

(b) The experiments on the fineness of milling of the pomace did not show any striking differences in the results. Until the middle of the summer following making the cider made from the most coarsely ground pomace was rather superior to those made from pomace ground more finely. The flavour and aroma were more delicate, and there was an absence of the slightly harsh character and flavour which appeared in the latter. The cider made from the most finely ground pomace possessed this character of harshness to a rather more marked degree than that made from pomace ground to a medium degree of fineness. Towards the end of the summer the two latter samples improved considerably and lost almost entirely their harshness in flavour. There was then practically no difference between all the types. The conclusion to be drawn from this series of experiments appears to be, that, while in the end the fineness of grinding does not make a great deal of difference to the result, there is, in the case of the more finely ground pomace, a tendency to coarseness in flavour during the first few months after making before the cider is properly matured. It is, perhaps, necessary to qualify this statement by applying it to pomace from mills of the grater type only. It is possible that the results with pomace from mills of the crusher type may differ considerably.

(c) The trials with fruit milled in unripe, ripe, and over-ripe condition gave results similar to those obtained when such trials were made at the Institute a few seasons ago. The cider from unripe fruit was less full-bodied, brisker, and harsher in character than that from the other two sets of fruit. The product from ripe

fruit was much softer than the preceding, fuller-bodied, and of a decidedly superior flavour. That from over-ripe fruit was again softer still, but, although fairly full-bodied, the distinctive character was to a large extent lost, and there was a marked tendency to insipidity.

(d) The comparative experiments on the effect of checking fermentation by racking and filtration respectively also gave results similar to those obtained when trials of this sort were made some seasons ago. The natural rate of fermentation of the juice proved to be the dominant factor in the result obtained. In juices with a low natural rate of fermentation racking proved sufficient to check fermentation almost as well as filtration. Generally in such cases the flavour of the cider was, on the whole, slightly superior in the racked samples to that of the filtered samples. The latter, however, were the more brilliant in appearance. In cases where the natural rates of fermentation of the juices were relatively fast, racking, even when repeated frequently, did not prove sufficient to check fermentation enough to retain the desired degree of sweetness in the liquor; and on that account, with juices of the more rapidly fermenting type, filtration is to be greatly preferred to racking, when sweet ciders are required.

The following notes indicate the principal characters of the respective ciders :—

CIDERS.

Sharp Varieties. (Juice containing normally more than .45 per cent. malic acid).

Brice's Kernel (Lydney, Gloucester).

Analysis of fresh juice, October 29th, 1914:

Specific gravity	..	..	..	1.043
Malic Acid	..	..	..	.85%
Tannin	..	..	..	14%

Weight of fruit, 904lbs.

Yield of juice, 664lbs.

Average daily fall in specific gravity at 28°C., .0095.

Filtered November 9th, 1914. Specific gravity, 1.009.

Specific gravity in bottle, May 1st, 1915, 1.003.

REMARKS: A clean, thin, dry cider, with a pronounced and penetrating acid flavour.

Useful for blending, but much too sharp alone.

Backwell Red (Backwell, Somerset).

Analysis of fresh juice, October 26th, 1914:

Specific gravity	..	..	..	1.046
Malic Acid	..	..	..	.62%
Tannin	..	..	..	.09%

Weight of fruit, 1,028lbs.

Yield of juice, 782lbs.

Average daily fall in specific gravity at 28°C., -0035.

Filtered November 18th, 1914. Specific gravity, 1·030.

Specific gravity in bottle, May 1st, 1915, 1·028.

REMARKS: A very soft, sweet cider of fair body and pleasant aroma and flavour.

Hardly of first quality, but good for ordinary use unblended.

Bickington Grey (Newton Abbot, Devon).

Analysis of fresh juice, November 17th, 1914:

Specific gravity	..	..	..	1·053
Malic Acid	..	..	..	·95%
Tannin	..	..	..	·13%

Weight of fruit, 1,410lbs.

Yield of juice, 970lbs.

Average daily fall in specific gravity at 28°C., -0068.

Filtered December 17th, 1914. Specific gravity, 1·030.

Specific gravity in bottle, May 1st, 1915, 1·024.

REMARKS: A medium sweet, clean, very sharp cider of good body. The flavour was markedly astringent, and also rather harsh.

Useful for blending, but too sharp and harsh for use alone.

Butter Box (Newton Abbot, Devon).

Analysis of fresh juice, November 4th, 1914:

Specific gravity	..	..	..	1·047
Malic Acid	..	..	..	·64%
Tannin	..	..	..	·21%

Weight of fruit, 1,105lbs.

Yield of juice, 941lbs.

Average daily fall in specific gravity at 28°C., -0046.

Filtered December 16th, 1914. Specific gravity, 1·031.

Specific gravity in bottle, May 1st, 1915, 1·028.

REMARKS: A very clean, sweet cider, of a moderate degree of briskness and pleasant flavour and aroma.

Useful unblended.

Cap of Liberty (Long Ashton, Somerset).

Analysis of fresh juice, November 4th, 1914:

Specific gravity	..	..	..	1·048
Malic Acid	..	..	..	·63%
Tannin	..	..	..	·24%

Weight of fruit, 447lbs.

Yield of juice, 327lbs.

Average daily fall in specific gravity at 28°C., -0062.

Filtered November 18th, 1914. Specific gravity, 1·027.

Specific gravity in bottle, May 1st, 1915, 1·021.

REMARKS: A medium sweet, rather brisk cider, of somewhat harsh character, but of good, clean, acid flavour.

Useful for blending.

Cap of Liberty (Brockley, Somerset).

Analysis of fresh juice, November 26th, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.76%
Tannin	..	..	..	.26%

Average daily fall in specific gravity at 28°C., .005.

Filtered December 22nd, 1914. Specific gravity, 1.035.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A cider very similar in character to the preceding, but appreciably softer on the palate.

Cap of Liberty A. (Martock, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.046
Malic Acid	..	..	..	.75%
Tannin	..	..	..	.20%

Weight of fruit, 3,611lbs.

Yield of juice, 2,642lbs.

Average daily fall in specific gravity at 28°C., .0021.

Filtered December 17th, 1914. Specific gravity, 1.035.

Specific gravity in bottle, May 1st, 1915, 1.031.

REMARKS: A fine coloured cider of excellent quality. Aroma good, flavour sweet and pleasantly sharp. In spite of the high acidity very pleasant unblended.

Excellent for blending.

This sample was fermented naturally.

Cap of Liberty B. (Martock, Somerset).

Analysis of fresh juice, etc., the same as for Cap of Liberty A.

Specific gravity in bottle, May 1st, 1915, 1.033.

REMARKS: This sample was fermented with yeast No. 37 (Riesling), and was very similar in character to the preceding, but slightly softer on the palate.

Cap of Liberty C. (Martock, Somerset).

Analysis of fresh juice, etc., the same as for Cap of Liberty A.

Specific gravity in bottle, May 1st, 1915, 1.031.

REMARKS: This sample was fermented with yeast No. 34 (Laureiro). Its character was almost indistinguishable from the preceding.

Cap of Liberty (South Petherton, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.046
Malic Acid	..	..	..	.85%
Tannin	..	..	..	.21%

Weight of fruit, 2,190lbs.

Yield of juice, 1,634lbs.

Average daily fall in specific gravity at 28°C., .0026.

Filtered February 16th, 1915. Specific gravity, 1.036.

Specific gravity in bottle, May 1st, 1915, 1.033.

REMARKS: A cider of brilliant reddish colour and excellent quality. Flavour sweet, with a pleasant well-marked acidity and aroma, very good. Excellent for use alone, notwithstanding its high acidity, or for blending.

Cherry Pearmain (Weobley, Hereford).

Analysis of fresh juice, November 3rd, 1914:

Specific gravity	..	..	..	1.056
Malic Acid	..	..	..	.57%
Tannin	..	..	..	.24%

Weight of fruit, 677lbs.

Yield of juice, 508lbs.

Average daily fall in specific gravity at 28°C., .004.

Filtered December 21st, 1914. Specific gravity, 1.032.

Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: A medium, brisk, soft, sweet cider of good clean flavour and pleasant aroma, but possessing an after-taste not altogether pleasant.

Very fair for use alone.

College A. (Nunnington, Hereford).

Analysis of fresh juice, November 4th, 1914:

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.75%
Tannin	..	..	..	.20%

Weight of fruit, 2,266lbs.

Yield of juice, 1,808lbs.

Average daily fall in specific gravity at 28°C., .0033.

Filtered December 12th, 1914. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.025.

REMARKS: A rather sweet cider of pleasant, clean, brisk, but rather hard flavour.

Rather too acid unblended, but good for blending.

This sample was fermented naturally.

College B. (Nunnington, Hereford).

Analysis of fresh juice, etc., the same as for College A.

Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: This sample was fermented with Yeast No. 31 (Rüdesheimer). Rather sweeter than the preceding, and perhaps slightly more delicate in flavour: otherwise very similar.

Dufflin A. (Truro, Cornwall).

Analysis of fresh juice, October 19th, 1914:

Specific gravity	..	..	..	1.060
Malic Acid	..	..	..	.80%
Tannin	..	..	..	.18%

Weight of fruit, 1,637lbs.

Yield of juice, 1,298lbs.

Average daily fall in specific gravity at 28°C., .0031.

Filtered December 16th, 1914. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.023.

REMARKS: A medium sweet, sharp cider, with a characteristic acid flavour typical for this variety. Considering the high acidity the sample was decidedly soft in character.

Too sharp for use alone, but good for blending.

This sample was fermented naturally.

Duffin B. (Truro, Cornwall).

Analysis of fresh juice, etc., the same as for Duffin A.

Specific gravity in bottle, May 1st, 1915, 1.023.

REMARKS: This sample was fermented with Yeast No. 37 (Riesling). The flavour was somewhat harsher than that of the preceding sample, and the acid character was different, but not unpleasant. This sample was less generally liked than the preceding.

Foxwhelp (Nunnington, Hereford).

Analysis of fresh juice, November 4th, 1914:

Specific gravity	..	..	..	1.061
Malic Acid	..	..	..	.95%
Tannin	..	..	..	.41%

Weight of fruit, 550lbs.

Yield of juice, 374lbs.

Average daily fall in specific gravity at 28°C., .0018.

Filtered January 26th, 1915. Specific gravity, 1.040.

Specific gravity in bottle, May 1st, 1915, 1.038.

REMARKS: A sweet, rather full-bodied cider of marked acidity and decided astringency. Flavour and aroma clean and pleasant. This sample improved considerably in bottle with age, a feature which is generally recognised as characteristic of this variety.

After maturing in bottle some time this cider was excellent unblended.

Galliardiott (Brockley, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.045
Malic Acid	..	..	..	.83%
Tannin	..	..	..	.14%

Weight of fruit, 224lbs.

Yield of juice, 170lbs.

Average daily fall in specific gravity at 28°C., .004.

Filtered December 2nd, 1914. Specific gravity 1.020.

Specific gravity in bottle, May 1st, 1915, 1.013.

REMARKS: A thin, medium dry cider of good aroma, and a characteristic rather woody acid flavour.

Unsuited for use alone, but fair for blending.

Kingston Black A. (Tintinhull, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.053
Malic Acid	..	..	..	.47%
Tannin	..	..	..	.17%

Weight of fruit, 2,268lbs.

Yield of juice, 1,663lbs.

Average daily fall in specific gravity at 28°C., .0042.

Filtered January 21st, 1915. Specific gravity, 1.028.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A medium sweet cider of fair body. Flavour moderately good, but rather flat and decidedly astringent, and with a woody character.

Fair for use alone.

This sample was fermented naturally.

Kingston Black B. (Tintinhull, Somerset).

Analysis of fresh juice, etc., the same as for Kingston Black A.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: This sample was fermented with Yeast No. 28 (Kingston Black). Its general character was practically the same as that of the preceding.

Kingston Black C. (Tintinhull, Somerset).

Analysis of fresh juice, etc., the same as for Kingston Black A.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: This cider was fermented with Yeast No. 37 (Riesling). It was decidedly brisker and more delicate than the two preceding samples, but otherwise very similar.

Kingston Black (Brockley, Somerset).

Analysis of fresh juice, November 26th, 1914:

Specific gravity	..	..	..	1.061
Malic Acid	..	..	..	.45%
Tannin	..	..	..	.19%

Average daily fall in specific gravity at 28°C., .0055.

Filtered January 4th, 1915. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A medium sweet cider of fair briskness and marked softness; pleasant, but lacking in character.

Very fair unblended.

Kingston Black (Staplegrave, Somerset).

Analysis of fresh juice, November 3rd, 1914:

Specific gravity	..	..	..	1.053
Malic acid	..	..	..	.44%
Tannin	..	..	..	.17%

Weight of fruit, 1,656lbs.

Yield of juice, 1,294lbs.

Average daily fall in specific gravity at 28°C., .0047.

Filtered January 20th, 1915. Specific gravity, 1.029.

Specific gravity in bottle, May 1st, 1915, 1.026.

REMARKS: This cider was similar to the three Tintinhull samples from the same variety, but more delicate and of decidedly better quality.

Kingston Black (White Lackington, Somerset).

Analysis of fresh juice, November 9th, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.43%
Tannin	..	..	..	.15%

Weight of fruit, 2,128lbs.

Yield of juice, 1,586lbs.

Average daily fall in specific gravity at 28°C., .005.

Filtered January 20th, 1915. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: A cider of the same general character as the preceding sample, but rather softer.

Kingston Black (Norton Fitzwarren, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.41%
Tannin	..	..	..	.15%

Weight of fruit, 1,120lbs.

Yield of juice, 856lbs.

Average daily fall in specific gravity at 28°C., .0043.

Filtered January 18th, 1915. Specific gravity, 1.029.

Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: A sweet, full-bodied cider of pleasant flavour and aroma, but slightly lacking in briskness.

Good unblended. One of the best Kingston Black samples for the season, although rather below the usual standard of the variety.

Kingston Black (Oldbury, Gloucester).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.45%
Tannin	..	..	..	.15%

Weight of fruit, 1,120lbs.

Yield of juice, 850lbs.

Average daily fall in specific gravity at 28°C., .0051.

Filtered January 22nd, 1915. Specific gravity, 1.031.

Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: A very similar cider to the preceding; of soft character and good quality.

Kingston Black A. (Hereford).

Analysis of fresh juice, November 2nd, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.55%
Tannin	..	..	..	.24%

Weight of fruit, 3,207lbs.

Yield of juice, 2,269lbs.

Average daily fall in specific gravity at 28°C., .0044.

Filtered January 19th, 1915. Specific gravity, 1.033.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: A brisker cider than the preceding, otherwise of the same general character.

This sample was fermented naturally.

Kingston Black B. (Hereford).

Analysis of fresh juice, etc., the same as for the preceding sample.

Specific gravity in bottle, May 1st, 1915, 1.033.

REMARKS: This sample was fermented with Yeast No. 30 (Forst). Of rather better quality than the preceding, the briskness being slightly more marked.

Kingston Black A. (Martock, Somerset).

Analysis of fresh juice, November 3rd, 1914:

Specific gravity	..	..	..	1.052
Malic Acid	..	..	..	.47%
Tannin	..	..	..	.19%

Weight of fruit, 2,360lbs.

Yield of juice, 1,961lbs.

Average daily fall in specific gravity at 28°C., .0029.

Filtered January 18th, 1915. Specific gravity, 1.034.

Specific gravity in bottle, May 1st, 1915, 1.032.

REMARKS: A good, rich cider, of a delicate aroma and flavour; rather less brisk than the samples made from Hereford fruit.

This cider was fermented naturally.

Kingston Black B. (Martock, Somerset).

Analysis of fresh juice, etc., the same as for the preceding sample.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: This cider was fermented with Yeast No. 37 (Riesling). A softer sample than the preceding, but with the same general character.

Kingston Black (Tibberton, Gloucester).

Analysis of fresh juice, November 26th, 1914:

Specific gravity	..	..	..	1.060
Malic Acid	..	..	..	.50%
Tannin	..	..	..	.16%

Average daily fall in specific gravity at 28°C., .0045.

Filtered January 12th, 1915. Specific gravity, 1.032.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: A sweet cider of medium briskness, rather rougher than most of the other samples of this variety, and not of such good quality as regards flavour.

Lambrook Pippin A. (South Petherton, Somerset).

Analysis of fresh juice, November 27th, 1914:

Specific gravity	..	..	..	1.046
Malic Acid	..	..	..	.59%
Tannin	..	..	..	.18%

Weight of fruit, 2,630lbs.

Yield of juice, 1,830lbs.

Average daily fall in specific gravity at 28°C., .0022.

Filtered December 22nd, 1914. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: A fairly sweet cider with a moderate degree of briskness. Flavour pleasant, but rather harsh. Adapted for use alone, although not of special quality.

The fruit used for this sample was milled when it was slightly unripe, and the pomace was ground to a medium degree of fineness.

Lambrook Pippin B. (South Petherton, Somerset).

Analysis of fresh juice, etc., the same as for Lambrook Pippin A.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: This sample was made from the same lot of fruit as the preceding, milled at the same time, but with the pomace ground more coarsely.

Its general character was the same, but the flavour and aroma were more delicate.

Lambrook Pippin C. (South Petherton, Somerset).

Analysis of fresh juice, etc., the same as for Lambrook Pippin A.
Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: This sample was made from the same lot of fruit as the two preceding samples, milled at the same time, but with the pomace ground to an extreme degree of fineness. Its character was appreciably harsher and more bitter than that of the preceding samples, but otherwise very similar.

Lambrook Pippin D. (South Petherton, Somerset).

Analysis of fresh juice, December 21st, 1914:

Specific gravity	..	..	..	1.047
Malic Acid	..	..	..	.45%
Tannin	..	..	..	.22%

Weight of fruit, 2,630lbs.

Yield of juice, 1,830lbs.

Average daily fall in specific gravity at 28°C., .0038.

Filtered February 16th, 1915. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.026.

REMARKS: This cider was made from the same lot of fruit as the three preceding samples, but was milled nearly four weeks later, when the fruit was perfectly ripe. Its type was generally similar, but it was much softer and of altogether better quality.

Lambrook Pippin E. (South Petherton, Somerset).

Analysis of fresh juice, January 14th, 1915:

Specific gravity	..	..	..	1.044
Malic Acid	..	..	..	.50%
Tannin	..	..	..	.18%

Average daily fall in specific gravity at 28°C., .0042.

Racked January 27th, February 15th, and April 2nd. Specific gravity, 1.028.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: This cider was made from the same lot of fruit as the four preceding samples, but the fruit was not milled until nearly four weeks later than the last (D). The fruit was then decidedly over-ripe, although in good general condition. The nature of the cider was similar to, but much softer than, any of the other samples of the series. There was, however, a decided loss of quality and character, and the flavour was comparatively insipid.

Page's Yellow (Lydney, Gloucester).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1.049
Malic Acid	..	..	..	.64%
Tannin	..	..	..	.12%

Weight of fruit, 1,071lbs.

Yield of juice, 795lbs.

Average daily fall in specific gravity at 28°C., .006.

Filtered November 16th, 1914. Specific gravity, 1.029.

Specific gravity in bottle, May 1st, 1915, 1.023.

REMARKS: A clean, pleasantly brisk, medium sweet cider, of good aroma and fair flavour, but lacking in character. On this account it was more useful for blending than for use alone.

Pople's Gutter Apple (Backwell, Somerset).

Analysis of fresh juice, 4th December, 1914:

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.83%
Tannin	..	..	..	.27%

Weight of fruit, 1,120lbs.

Yield of juice, 742lbs.

Average daily fall in specific gravity at 28°C., .0051.

Filtered January 19th, 1915. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.026.

REMARKS: A sweet cider of marked acidity and harsh flavour, suggestive of unripeness of fruit at the time of milling.

Inferior alone, but fairly useful for blending.

Porter's Perfection (South Petherton, Somerset).

Analysis of fresh juice, December 21st, 1914:

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.60%
Tannin	..	..	..	.25%

Weight of fruit, 364lbs.

Yield of juice, 252lbs.

Average daily fall in specific gravity at 28°C., .0027.

Filtered January 12th, 1915. Specific gravity, 1.036.

Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: A rather thin, but sweet cider of pleasant medium-brisk flavour and aroma.

Good unblended, although lacking in body.

Redstreak (Ledbury, Hereford).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.75%
Tannin	..	..	..	.17%

Weight of fruit, 1,040lbs.

Yield of juice, 758lbs.

Average daily fall in specific gravity at 28°C., .0041.

Filtered November 23rd, 1914. Specific gravity, 1.028.

Specific gravity in bottle, May 1st, 1915, 1.025.

REMARKS: A good, brisk, full-bodied, sweet cider, spoilt by a distinct Penicillium taint, due probably to storage in a bad cask.

Rather brisk for use alone, but valuable for blending.

Rouge de Trèves (Brockley, Somerset).

Analysis of fresh juice, December 21st, 1914:

Specific gravity	..	..	..	1.045
Malic Acid	..	..	..	.77%
Tannin	..	..	..	.15%

Weight of fruit, 224lbs.

Yield of juice, 163lbs.

Average daily fall in specific gravity at 28°C., ·0055.

Filtered January 12th, 1915. Specific gravity, 1·021.

Specific gravity in bottle, May 1st, 1915, 1·015.

REMARKS: A good medium, dry cider of clean somewhat acid flavour, marred, however, by a slight taint of *Penicillium* flavour, due probably to storage in a slightly mouldy cask.

A useful cider for blending.

Teign Harvey (Newton Abbot, Devon).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1·046
Malic Acid	..	..	..	·58%
Tannin	..	..	..	·31%

Weight of fruit, 1,404lbs.

Yield of juice, 1,115lbs.

Average daily fall in specific gravity at 28°C., ·0032.

Filtered November 17th, 1914. Specific gravity, 1·029.

Specific gravity in bottle, May 1st, 1915, 1·024.

REMARKS: A sweet, medium brisk cider, of fair quality, rather lacking in body. A marked *Penicillium* taint, due to the storage cask, spoiled the sample.

More useful for blending than for use alone.

Yellow Styre (Lydney, Gloucester).

Analysis of fresh juice, November 2nd, 1914:

Specific gravity	..	..	..	1·060
Malic Acid	..	..	..	·62%
Tannin	..	..	..	·25%

Weight of fruit, 1,002lbs.

Yield of juice, 679lbs.

Average daily fall in specific gravity at 28°C., ·0055.

Filtered December 14th, 1914. Specific gravity 1·024.

Specific gravity in bottle, May 1st, 1915, 1·021.

REMARKS: A medium sweet, brisk cider with the tannin character rather pronounced, decidedly softer than usual for this variety.

Very fair alone and good for blending.

Sweet Varieties. (Juice containing normally less than ·45 per cent. malic acid and ·2 per cent. tannin.)

Court Royal (Long Ashton, Somerset).

Analysis of fresh juice, October 19th, 1914:

Specific gravity	..	..	..	1·045
Malic Acid	..	..	..	·23%
Tannin	..	..	..	·10%

Weight of fruit, 533lbs.

Yield of juice, 375lbs.

Average daily fall in specific gravity at 28°C., ·0112.

Filtered November 2nd, 1914. Specific gravity, 1·005.

Specific gravity in bottle, May 1st, 1915, 1·000.

REMARKS: A thin, coarse, dry cider, retaining a marked fermentation flavour, and of low acidity.

Inferior for blending.

Burstout (South Petherton, Somerset).

Analysis of fresh juice, November 9th, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.16%
Tannin	..	..	..	.10%

Weight of fruit, 2,242lbs.

Yield of juice, 1,660lbs.

Average daily fall in specific gravity at 28°C., .0055.

Filtered December 8th, 1914. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.013.

REMARKS: A medium dry cider, of low acidity and harsh flavour.

Inferior for blending.

Cremière (Backwell, Somerset).

Analysis of fresh juice, December 4th, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.21%
Tannin	..	..	..	.17%

Weight of fruit, 1,120lbs.

Yield of juice, 763lbs.

Average daily fall in specific gravity at 28°C., .0083.

Filtered December 22nd, 1914. Specific gravity, 1.021.

Specific gravity in bottle, May 1st, 1915, 1.015.

REMARKS: A rather better cider than the preceding, but of the same general character.

Moderately useful for blending.

Dove (North Cadbury, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.048
Malic Acid	..	..	..	.20%
Tannin	..	..	..	.18%

Weight of fruit, 1,120lbs.

Yield of juice, 899lbs.

Average daily fall in specific gravity at 28°C., .006.

Filtered December 20th, 1914. Specific gravity, 1.024.

Specific gravity in bottle, May 1st, 1915, 1.017.

REMARKS: A medium sweet cider of good body and pleasant flavour, a little marred by a slight degree of harshness.

Useful for blending with sharper varieties.

Fréquin de Chartres (Brockley, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.049
Malic Acid	..	..	..	.34%
Tannin	..	..	..	.17%

Weight of fruit, 526lbs.

Yield of juice, 412lbs.

Average daily fall in specific gravity at 28°C., .0078.

Filtered November 30th, 1914. Specific gravity 1.024.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: A medium sweet cider of good quality. Flavour delicate and pleasant, with a trace of bitterness.

Useful for blending.

Frogington Glory (North Cadbury, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.054
Malic Acid	..	..	..	.25%
Tannin	..	..	..	.19%

* Weight of fruit, 560lbs.

Yield of juice, 412lbs.

Average daily fall in specific gravity at 28°C., .005.

Filtered January 11th, 1915. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A medium sweet cider of typical Cadbury aroma and character, rather less full-bodied than usual from this locality.

Useful for blending.

Noir de Vitry (Brockley, Somerset).

Analysis of fresh juice, November 26th, 1914:

Specific gravity	..	..	..	1.047
Malic Acid	..	..	..	.26%
Tannin	..	..	..	.17%

Average daily fall in specific gravity at 28°C., .0073.

Filtered December 15th, 1914. Specific gravity, 1.020.

Specific gravity in bottle, May 1st, 1915, 1.016.

REMARKS: A medium dry, very harsh and bitter cider.

Inferior for blending. The quantity available was not sufficient to make a fair trial for the variety.

Rouge Bruyère (Brockley, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.24%
Tannin	..	..	..	.19%

Average daily fall in specific gravity at 28°C., .0094.

Filtered November 24th, 1914. Specific gravity, 1.025.

Specific gravity in bottle, May 1st, 1915, 1.015.

REMARKS: A rather thin, medium dry cider. Flavour fair and aroma good.

Fairly useful for blending with sharper types.

Rouge Latour (Brockley, Somerset).

Analysis of fresh juice, December 21st, 1914:

Specific gravity	..	..	..	1.065
Malic Acid	..	..	..	.38%
Tannin	..	..	..	.19%

Weight of fruit, 224lbs.

Yield of juice, 132lbs.

Average daily fall in specific gravity at 28°C., .0061.

Filtered February 9th, 1915. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.023.

REMARKS: A medium sweet, strong, but insipid, cider.

The quantity of fruit available was insufficient for a satisfactory trial.

Slack-ma-Girdle A. (Newton Abbot, Devon).

Analysis of fresh juice, November 17th, 1914:

Specific gravity	..	..	..	1.047
Malic Acid	..	..	..	.29%
Tannin	..	..	..	.15%

Weight of fruit, 1,767lbs.

Yield of juice, 1,345lbs.

Average daily fall in specific gravity at 28°C., .0043.

Filtered December 21st, 1914. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: A medium sweet cider of excellent quality and full body. Flavour very good, and aroma similar to that characteristic of ciders made in Cadbury district in Somerset.

This sample was fermented naturally.

Slack-ma-Girdle B. (Newton Abbot, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: This sample was fermented with Yeast No. 20 (Lambrook Pippin). Its character was like that of the preceding sample, but brisker.

Spotted White A. (Alphington, Devon).

Analysis of fresh juice, November 2nd, 1914:

Specific gravity	..	..	..	1.058
Malic Acid	..	..	..	.21%
Tannin	..	..	..	.16%

Weight of fruit, 2,554lbs.

Yield of juice, 2,031lbs.

Average daily fall in specific gravity at 28°C., .0063.

Filtered January 4th, 1915. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: A sweet cider of an insipid type, harsh in flavour and of full body.

Fairly useful for blending.

This sample was fermented naturally.

Spotted White B. (Alphington, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: This sample was fermented with Yeast No. 38 (India). Brisker than the preceding, but otherwise similar.

Spotted White C. (Alphington, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Racked December 3rd, January 5th, and February 1st. Specific gravity, 1.015.

Specific gravity in bottle, May 1st, 1915, 1.014.

REMARKS: This sample was not filtered, but racked instead three times. In general character similar to the two preceding samples, with the harshness in flavour exaggerated and with less sweetness.

Sweet Alford A. (Alphington, Devon).

Analysis of fresh juice, October 26th, 1914 :

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.17%
Tannin	..	..	..	.20%

Weight of fruit, 6,296lbs.

Yield of juice, 5,115lbs.

Average daily fall in specific gravity at 28°C., .0052.

Filtered January 26th, 1915. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.023.

REMARKS: A sweet cider of a rather insipid type. Flavour flat and lacking in briskness.

Useful for blending with sharper varieties.

This sample was fermented naturally.

Sweet Alford B. (Alphington, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: This cider was fermented with Yeast No. 32 (Steinberg). Similar to the preceding sample, but brisker. The best of the Sweet Alford series.

Sweet Alford C. (Alphington, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Filtered January 11th, 1915. Specific gravity, 1.022.

Specific gravity in bottle, May 1st, 1915, 1.021.

REMARKS: This sample was fermented with Yeast No. 33 (Piesport). A flatter and less pleasant type than the preceding.

Sweet Alford D. (Alphington, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Filtered January 11th, 1915. Specific gravity, 1.024.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: This sample was fermented with Yeast No. 35 (Rum yeast). Similar in general character to the other ciders of this series, but more insipid.

Sweet Alford E. (Alphington, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.

Filtered January 4th, 1915. Specific gravity, 1.021.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: This cider was fermented with pressed yeast. Very similar to the preceding sample, but flavour less pleasant.

Slack-ma-Girdle (Alphington, Devon).

Analysis of fresh juice, November 4th, 1914 :

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.22%
Tannin	..	..	..	.16%

Weight of fruit, 2,471lbs.

Yield of juice, 2,045lbs.

Average daily fall in specific gravity at 28°C., .0042.

Filtered January 25th, 1915. Specific gravity, 1.025.

Specific gravity in bottle, May 1st, 1915, 1.021.

REMARKS: A medium sweet cider of good body. Flavour pleasant, brisker and more astringent than usual for this variety. Upon the whole above the average of this kind.

Improved by blending with a sharper cider.

Bittersweet Varieties. Juice containing normally less than .45 per cent. malic acid, and more than .2 per cent. tannin).

Dabinett (Long Ashton, Somerset).

Analysis of fresh juice, December 4th, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.15%
Tannin	..	..	..	.28%

Average daily fall in specific gravity at 28°C., .0078.

Filtered January 4th, 1915. Specific gravity, 1.015.

Specific gravity in bottle, May 1st, 1915, 1.013.

REMARKS: A rather dry, bitter cider of inferior quality.
Inferior for blending.

Broadleaved French A. (Ross, Hereford).

Analysis of fresh juice, November 9th, 1914:

Specific gravity	..	..	..	1.053
Malic Acid	..	..	..	.22%
Tannin	..	..	..	.27%

Weight of fruit, 2,446lbs.

Yield of juice, 1,851lbs.

Average daily fall in specific gravity at 28°C., .0063.

Filtered November 30th, 1914. Specific gravity, 1.023.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: A medium sweet, clean cider. Flavour very fair, but rather hard and bitter.

Fairly useful for blending.

This sample was treated normally.

Broadleaved French B. (Ross, Hereford).

Analysis of fresh juice, etc., the same as for the preceding sample.

Racked November 30th and January 25th. Specific gravity, 1.017.

Specific gravity in bottle, May 1st, 1915, 1.011.

REMARKS: This sample was racked twice. A dry cider of very fair quality, softer than the preceding, but of the same general character.

Broadleaved French C. (Ross, Hereford).

Analysis of fresh juice, etc., the same as for the preceding sample.

Racked December 10th and January 25th. Specific gravity, 1.017.

Specific gravity in bottle, May 1st, 1915, 1.015.

REMARKS: This sample was racked at the same time as the preceding, and after the second racking cleared with gelatine (five-sixths of an ounce per hoghead). It was somewhat sweeter than the preceding sample, otherwise very similar.

Broadleaved French D. (Ross, Hereford).

Analysis of fresh juice, etc., the same as for the preceding sample.

Racked March 28th, 1915. Specific gravity, 1.007.

Specific gravity in bottle, May 1st, 1915, 1.004.

REMARKS: This sample was racked once. A very dry, extremely bitter cider. Flavour harsh and unpleasant, greatly inferior to the three preceding samples.

Brown Snout (Nunnington, Hereford).

Analysis of fresh juice, November 3rd, 1914:

Specific gravity	..	..	..	1.052
Malic Acid	..	..	..	.27%
Tannin	..	..	..	.30%

Weight of fruit, 2,128lbs.

Yield of juice, 1,472lbs.

Average daily fall in specific gravity at 28°C., .005.

Filtered December 15th, 1914. Specific gravity, 1.025.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: A moderately sweet cider of medium bitterness. Flavour pleasant and aromatic.

Useful for blending.

Buskin (North Cadbury, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.057
Malic Acid	..	..	..	.28%
Tannin	..	..	..	.21%

Weight of fruit, 1,120lbs.

Yield of juice, 803lbs.

Average daily fall in specific gravity at 28°C., .0061.

Filtered December 23rd, 1914. Specific gravity, 1.033.

Specific gravity in bottle, May 1st, 1915, 1.026.

REMARKS: A sweet cider of good body. Flavour clean, very pleasant and mildly bitter; aroma characteristic.

Rather lacking in acidity for use alone, but excellent for blending.

Chisel Jersey A. (South Petherton, Somerset).

Analysis of fresh juice, November 26th, 1914:

Specific gravity	..	..	..	1.058
Malic Acid	..	..	..	.23%
Tannin	..	..	..	.35%

Weight of fruit, 2,010lbs.

Yield of juice, 1,571lbs.

Average daily fall in specific gravity at 28°C., .0055.

Filtered February 1st, 1915. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: A sweet, fairly full-bodied cider. Flavour and aroma pleasant; bitterness rather marked.

Useful for blending.

This sample was treated normally.

Chisel Jersey B. (South Petherton, Somerset).

Analysis of fresh juice, etc., the same as for the preceding sample.
 Racked January 18th and February 1st. Specific gravity, 1.026.
 Specific gravity in bottle, May 1st, 1915, 1.025.

REMARKS: This sample was racked twice. It remained as sweet as the preceding sample, and possessed more character. Flavour delicate and very pleasant.

Chisel Jersey (North Cadbury, Somerset).

Analysis of fresh juice, December 3rd, 1914:

Specific gravity	..	..	..	1.058
Malic Acid	..	..	..	.19%
Tannin	..	..	..	.37%

Weight of fruit, 1,140lbs.

Yield of juice, 788lbs.

Average daily fall in specific gravity at 28°C., .006.

Filtered February 1st, 1915. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: Similar to the preceding two samples, but not so pleasant.

Dabinett A. (South Petherton, Somerset).

Analysis of fresh juice, November 17th, 1914:

Specific gravity	..	..	..	1.056
Malic Acid	..	..	..	.21%
Tannin	..	..	..	.23%

Weight of fruit, 1,353lbs.

Yield of juice, 829lbs.

Average daily fall in specific gravity at 28°C., .0043.

Filtered January 26th, 1915. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A medium sweet cider of good quality. Flavour and aroma pleasant.

Useful for blending.

This sample was fermented naturally.

Dabinett B. (South Petherton, Somerset).

Analysis of fresh juice, etc., the same as for the preceding sample.

Specific gravity in bottle, May 1st, 1915, 1.024.

REMARKS: This sample was fermented with Yeast No. 27 (Johannisberg). Similar to the preceding, but brisker.

Eggleton Styre A. (Ledbury, Hereford).

Analysis of fresh juice, November 2nd, 1914:

Specific gravity	..	..	..	1.069
Malic Acid	..	..	..	.36%
Tannin	..	..	..	.23%

Weight of fruit, 1,850lbs.

Yield of juice, 1,308lbs.

Average daily fall in specific gravity at 28°C., .0054.

Filtered December 15th, 1914. Specific gravity, 1.025.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A medium sweet cider of fair body. Flavour good, with a trace of acidity and fair bitterness.

Useful for blending.

This sample was fermented naturally.

Eggleton Styre B. (Ledbury, Hereford).

Analysis of fresh juice, etc., the same as for Eggleton Styre A.
Specific gravity in bottle, May 1st, 1915, 1·027.

REMARKS: This sample was fermented with Yeast No. 29 (Rhenish Wine).
Like the preceding, but appreciably better in quality.

Fillbarrel A. (North Cadbury, Somerset).

Analysis of fresh juice, December 3rd, 1914:

Specific gravity	..	..	..	1·058
Malic Acid	..	..	..	·20%
Tannin	..	..	..	·34%

Weight of fruit, 2,200lbs.

Yield of juice, 1,545lbs.

Average daily fall in specific gravity at 28°C., ·0053.

Filtered January 12th, 1915. Specific gravity, 1·023.

Specific gravity in bottle, May 1st, 1915, 1·017.

REMARKS: A good medium sweet cider of the bittersweet class, with
astringency well marked and fairly full bodied. A typical Cadbury sample.
This sample was fermented naturally.

Fillbarrel B. (North Cadbury, Somerset).

Analysis of fresh juice, etc., the same as for Fillbarrel A.
Specific gravity in bottle, May 1st, 1915, 1·021.

REMARKS: This sample was fermented with Yeast No. 37 (Riesling).
Similar to the preceding, but with the tannin character more marked and a
shade brisker.

Fillbarrel C. (North Cadbury, Somerset).

Analysis of fresh juice, etc., the same as for Fillbarrel A.

Racked December 12th, January 11th, and February 15th. Specific
gravity, 1·015.

Specific gravity in bottle, May 1st, 1915, 1·010.

REMARKS: This sample was racked three times, but not filtered. Drier
than the two preceding samples, and decidedly rougher and more bitter.

Frèquin Audièvre (Truro, Cornwall).

Analysis of fresh juice, December 4th, 1914.

Specific gravity	..	..	..	1·058
Malic Acid	..	..	..	·22%
Tannin	..	..	..	·29%

Weight of fruit, 336lbs.

Yield of juice, 234lbs.

Average daily fall in specific gravity at 28°C., ·0072.

Filtered January 12th, 1915. Specific gravity, 1·024.

Specific gravity in bottle, May 1st, 1915, 1·018.

REMARKS: A medium sweet, full-bodied cider, of pleasant flavour and
aroma.

Too lacking in acidity to use alone, but good for blending with sharper
kinds.

George James (North Cadbury, Somerset).

Analysis of fresh juice, December 3rd, 1914:

Specific gravity	..	..	..	1.045
Malic Acid	..	..	..	.18%
Tannin	..	..	..	.21%

Weight of fruit, 1,120lbs.

Yield of juice, 826lbs.

Average daily fall in specific gravity at 28°C., .0056.

Filtered December 22nd, 1914. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.017.

REMARKS: A medium sweet cider of the mild bittersweet type. Very good example of a typical Cadbury cider.

Very useful for blending with sharper types.

Harry Masters (North Cadbury, Somerset).

Analysis of fresh juice, December 4th, 1914:

Specific gravity	..	..	..	1.059
Malic Acid	..	..	..	.22%
Tannin	..	..	..	.27%

Weight of fruit, 694lbs.

Yield of juice, 456lbs.

Average daily fall in specific gravity at 28°C., .007.

Filtered January 11th, 1915. Specific gravity, 1.024.

Specific gravity in bottle, May 1st, 1915, 1.019.

REMARKS: A medium sweet cider of marked bitter character. Acidity low, flavour fair.

Moderately useful for blending.

Horner A. (South Petherton, Somerset).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1.056
Malic Acid	..	..	..	.14%
Tannin	..	..	..	.32%

Weight of fruit, 968lbs.

Yield of juice, 792lbs.

Average daily fall in specific gravity at 28°C., .0042.

Filtered March 15th, 1915. Specific gravity, 1.029.

Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: A very soft, rich, sweet cider, of the Cadbury type. The bittersweet character slightly marked. Flavour and aroma good.

Very useful for blending.

This sample was fermented naturally.

Horner B. (South Petherton, Somerset).

Analysis of fresh juice, etc., the same as for the preceding sample.

Filtered March 15th, 1915. Specific gravity, 1.021.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: This sample was fermented with pressed yeast. Similar in type to the preceding sample, but less sweet and with an inferior yeasty flavour.

Knotted Kernel (Weobley, Hereford).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.22%
Tannin	..	..	..	.49%

Weight of fruit, 1,086lbs.

Yield of juice, 771lbs.

Average daily fall in specific gravity at 28°C., .0045.

Filtered December 21st, 1914. Specific gravity, 1.029.

Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: A sweet, full-bodied cider of very pleasant flavour and a particularly good after-taste; aroma good. One of the best of the bittersweet ciders of the season.

Médaille d'Or (Long Ashton, Somerset).

Analysis of fresh juice, November 3rd, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.24%
Tannin	..	..	..	.47%

Weight of fruit, 730lbs.

Yield of juice, 554lbs.

Average daily fall in specific gravity at 28°C., .0087.

Filtered November 16th, 1914. Specific gravity, 1.022.

Specific gravity in bottle, May 1st, 1915, 1.017.

REMARKS: A clean-flavoured, medium sweet cider of marked bitter character and fair quality.

Useful in small quantities for blending.

Médaille d'Or (Truro, Cornwall).

Analysis of fresh juice, November 17th, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.21%
Tannin	..	..	..	.43%

Weight of fruit, 224lbs.

Yield of juice, 123lbs.

Average daily fall in specific gravity at 28°C., .0041.

Filtered January 6th, 1915. Specific gravity, 1.025.

Specific gravity in bottle, May 1st, 1915, 1.020.

REMARKS: A medium sweet, very bitter cider, of fair quality. Flavour raw, and after-taste very rough.

Only suited for blending in small quantities.

Muscadet (Brockley, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.057
Malic Acid	..	..	..	.30%
Tannin	..	..	..	.23%

Weight of fruit, 721lbs.
 Yield of juice, 549lbs.
 Average daily fall in specific gravity at 28°C., .0086.
 Filtered November 30th, 1914. Specific gravity, 1.024.
 Specific gravity in bottle, May 1st, 1915, 1.018.

REMARKS: A moderately sweet cider with a pleasant flavour, possessing a medium degree of bitterness. Aroma well marked and aromatic.
 Useful for blending.

Newton Jersey A. (Newton St. Cyres, Devon).

Analysis of fresh juice, November 2nd, 1914:

Specific gravity	..	..	..	1.047
Malic Acid	..	..	..	.27%
Tannin	..	..	..	.28%

Weight of fruit, 1,841lbs.
 Yield of juice, 1,503lbs.
 Average daily fall in specific gravity at 28°C., .0033.
 Filtered January 4th, 1915. Specific gravity, 1.030.
 Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: A sweet, medium bitter cider of fair body and characteristic aromatic flavour.

Useful for blending.

This cider was treated normally.

Newton Jersey B. (Newton St. Cyres, Devon).

Analysis of fresh juice, etc., the same as for the preceding sample.
 Racked January 4th and February 8th. Specific gravity, 1.028.
 Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: This sample was racked twice. A similar cider to the preceding, but of greater body and more pronounced character.

Royal Jersey A. (Martock, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.048
Malic Acid	..	..	..	.27%
Tannin	..	..	..	.27%

Weight of fruit, 1,163lbs.
 Yield of juice, 870lbs.
 Average daily fall in specific gravity at 28°C., .005.
 Filtered March 16th, 1915. Specific gravity, 1.025.
 Specific gravity in bottle, May 1st, 1915, 1.021.

REMARKS: A medium sweet, full-bodied cider of a moderate degree of bitterness.

Useful for blending.

This cider was fermented naturally.

Royal Jersey B. (Martock, Somerset).

Analysis of fresh juice, etc., the same as for the preceding sample.
 Filtered March 1st, 1915. Specific gravity, 1.025.
 Specific gravity in bottle, May 1st, 1915, 1.021.

REMARKS: This sample was fermented with pressed yeast. Inferior to the preceding, and rapidly affected with cider sickness.

Royal Jersey (North Cadbury, Somerset).

Analysis of fresh juice, December 3rd, 1914 :

Specific gravity	..	..	..	1.060
Malic Acid	..	..	..	.17%
Tannin	..	..	..	.35%

Weight of fruit, 1,110lbs.

Yield of juice, 778lbs.

Average daily fall in specific gravity at 28°C., .0067.

Filtered March 15th, 1915. Specific gravity, 1.025.

Specific gravity in bottle, May 1st, 1915, 1.022.

REMARKS: A rough, bitter cider, full-bodied and with fair flavour, lacking in briskness.

Moderately useful for blending.

Strawberry Norman (Long Ashton, Somerset).

Analysis of fresh juice, November 4th, 1914 :

Specific gravity	..	..	..	1.050
Malic Acid	..	..	..	.40%
Tannin	..	..	..	.42%

Weight of fruit, 696lbs.

Yield of juice, 496lbs.

Average daily fall in specific gravity at 28°C., .0052.

Filtered November 30th, 1914. Specific gravity, 1.028.

Specific gravity in bottle, May 1st, 1915, 1.018.

REMARKS: A somewhat thin, rather harsh and bitter cider of the bitter-sweet type.

Moderate for blending.

Strawberry Norman (Weobley, Hereford).

Analysis of fresh juice, November 2nd, 1914 :

Specific gravity	..	..	..	1.057
Malic Acid	..	..	..	.34%
Tannin	..	..	..	.45%

Weight of fruit, 1,224lbs.

Yield of juice, 894lbs.

Average daily fall in specific gravity at 28°C., .0043.

Filtered December 22nd, 1914. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.023.

REMARKS: A rather sweet cider. Flavour and aroma very fair. The bittersweet character well marked.

A useful cider for blending

Tardive Forestier (Brockley, Somerset).

Analysis of fresh juice, November 26th, 1914 :

Specific gravity	..	..	..	1.048
Malic Acid	..	..	..	.27%
Tannin	..	..	..	.38%

Average daily fall in specific gravity at 28°C., .0063.

Filtered December 14th, 1914. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.016.

REMARKS: A medium sweet, clean-flavoured cider, somewhat astringent
Useful for blending.

Twistbody Jersey (North Cadbury, Somerset).

Analysis of fresh juice, December 3rd, 1914:

Specific gravity	..	..	..	1.056
Malic Acid	..	..	..	.18%
Tannin	..	..	..	.24%

Weight of fruit, 553lbs.

Yield of juice, 355lbs.

Average daily fall in specific gravity at 28°C., .006.

Filtered March 15th, 1915. Specific gravity, 1.034.

Specific gravity in bottle, May 1st, 1915, 1.032.

REMARKS: A rich, sweet, full-bodied cider, with good aroma and flavour.
Very useful for blending.

Twistbody Jersey A. (Martock, Somerset).

Analysis of fresh juice, November 10th, 1914:

Specific gravity	..	..	..	1.059
Malic Acid	..	..	..	.20%
Tannin	..	..	..	.43%

Weight of fruit, 2,338lbs.

Yield of juice, 1,685lbs.

Average daily fall in specific gravity at 28°C., .0058.

Filtered April 4th, 1915. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: A sweet, full-bodied cider, more bitter than the preceding,
but otherwise pleasantly flavoured.

Very useful for blending.

This sample was fermented naturally.

Twistbody Jersey B. (Martock, Somerset).

Analysis of fresh juice, etc., the same as for the preceding sample.

Filtered March 25th, 1915. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: This sample was fermented with pressed yeast. A sweet-
full-bodied, bitter cider. Flavour and aroma unpleasant; greatly inferior
to the preceding sample.

White Jersey (North Cadbury, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.055
Malic Acid	..	..	..	.27%
Tannin	..	..	..	.27%

Weight of fruit, 560lbs.

Yield of juice, 368lbs.

Average daily fall in specific gravity at 28°C., .0037.

Filtered February 15th, 1915. Specific gravity, 1.033.

Specific gravity in bottle, May 1st, 1915, 1.028.

REMARKS: A cider of the same type as the preceding, with rather less
bitterness. The Cadbury character pronounced.

Excellent for blending.

White Norman (Weobley, Hereford).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1.047
Malic Acid	..	..	..	.19%
Tannin	..	..	..	.35%

Weight of fruit, 1,469lbs.

Yield of juice, 1,137lbs.

Average daily fall in specific gravity at 28°C., .0045.

Filtered February 3rd, 1915. Specific gravity, 1.023.

Specific gravity in bottle, May 1st, 1915, 1.016.

REMARKS: A medium dry, bitter cider, of unpleasant aromatic character.
Inferior for blending. Much below the usual standard of this variety.

Yarlington Mill (North Cadbury, Somerset).

Analysis of fresh juice, November 16th, 1914:

Specific gravity	..	..	..	1.043
Malic Acid	..	..	..	.19%
Tannin	..	..	..	.21%

Weight of fruit, 2,128lbs.

Yield of juice, 1,566lbs.

Average daily fall in specific gravity at 28°C., .005.

Filtered December 20th, 1914. Specific gravity, 1.027.

Specific gravity in bottle, May 1st, 1915, 1.019.

REMARKS: A medium sweet cider of strong Cadbury character. Bitterness well marked, but acidity low.
Useful for blending.

PERRIES.**Red (Ledbury, Hereford).**

Analysis of fresh juice, October 26th, 1914:

Specific gravity	..	..	..	1.051
Malic Acid	..	..	..	.28%
Tannin	..	..	..	.16%

Weight of fruit, 830lbs.

Yield of juice, 618lbs.

Average daily fall in specific gravity at 28°C., .0051.

Filtered November 30th, 1914. Specific gravity, 1.026.

Specific gravity in bottle, May 1st, 1915, 1.021.

REMARKS: A medium, rather sickly, sweet perry of unattractive flavour and aroma.

Lacking in briskness for use alone.

Butt (Ledbury, Hereford).

Analysis of fresh juice, October 27th, 1914:

Specific gravity	..	..	..	1.061
Malic Acid	..	..	..	.74%
Tannin	..	..	..	.26%

Weight of fruit, 1,039lbs.

Yield of juice, 763lbs.

Average daily fall in specific gravity at 28°C., .0032.

Filtered December 21st, 1914. Specific gravity, 1.032.

Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: A good, full bodied perry. Flavour pleasant, but rather acid and bitter.

Oldfield (Tibberton, Gloucester).

Analysis of fresh juice, November 23rd, 1914 :

Specific gravity	..	..	..	1.054
Malic Acid	..	..	..	.61%
Tannin	..	..	..	.09%

Weight of fruit, 1,132lbs.

Yield of juice, 725lbs.

Average daily fall in specific gravity at 28°C., .0031.

Filtered December 21st, 1914. Specific gravity, 1.032.

Specific gravity in bottle, May 1st, 1915, 1.027.

REMARKS: A sweet perry of unattractive flavour. Below the usual standard of this variety.

Oldfield (Hardwicke, Gloucester).

Analysis of fresh juice, November 16th, 1914 :

Specific gravity	..	..	..	1.048
Malic Acid	..	..	..	.93%
Tannin	..	..	..	.05%

Weight of fruit, 2,240lbs.

Yield of juice, 1,736lbs.

Average daily fall in specific gravity at 28°C., .0031.

Filtered December 14th, 1914. Specific gravity, 1.030.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: A very sharp, sweet perry of inferior flavour.

Oldfield (Marden, Hereford).

Analysis of fresh juice, November 16th, 1914 :

Specific gravity	..	..	..	1.057
Malic Acid	..	..	..	.59%
Tannin	..	..	..	.12%

Weight of fruit, 1,400lbs.

Yield of juice, 1,150lbs.

Average daily fall in specific gravity at 28°C., .0047.

Filtered January 4th, 1915. Specific gravity, 1.033.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: A full-bodied sweet perry. Flavour very pleasant and brisk.

Oldfield (Ledbury, Hereford).

Analysis of fresh juice, November 4th, 1914 :

Specific gravity	..	..	..	1.057
Malic Acid	..	..	..	.59%
Tannin	..	..	..	.47%

Weight of fruit, 410lbs.

Yield of juice, 304lbs.

Average daily fall in specific gravity at 28°C., .0016.

Filtered January 25th, 1915. Specific gravity, 1.036.

Specific gravity in bottle, May 1st, 1915, 1.029.

REMARKS: A sweet, full-bodied perry, rather sickly in flavour, but possessing the characteristic Oldfield astringent after-taste. Aroma well marked.

THE ACETIC BACTERIA OF CIDER.

BY OTTO GROVE.

For some time a number of acid-forming bacteria have been isolated from samples of acetified ciders and examined in pure cultures. The object has been to find out how many different varieties of acetic bacteria occur in ciders, and what are their principal characters and properties. The important rôle these bacteria play in connection with cider and perry has already been pointed out in preceding reports, and the different ways of preventing acetification have been mentioned.

Between thirty and forty acetified ciders have been examined and from these five different types of bacteria have been isolated. Of these four were quite distinct species, the fifth, perhaps, being only a variation of one of the other types. The most common of the species found was the one described as No. 1, the well-known *Bacterium xylinum*. The four other types were less frequently found; in some cases one or more of them were present together with *Bacterium xylinum*.

The following are the principal characters of the five types of bacteria, as shown by cultures in a malt-extract solution of a specific gravity of 1.040 to which was added, after sterilisation, 2 per cent. of alcohol, and under other conditions.

No. 1. *Bacterium xylinum*. After three days at 25°C., a thick, leathery, yellowish, transparent film is formed on the surface of the liquid. This film is very characteristic, and so strong that it can be lifted out of the culture-flask in one piece. The liquid remains clear and no deposit is formed. After keeping the culture-flasks for some time the film gradually sinks in the liquid, and a new one is formed upon the surface. This process goes on, until the whole flask is filled with layers of film. On malt-extract-gelatine small, raised, sticky colonies of a yellowish-transparent colour are slowly formed. The bacterium is a small rod without motility or spore-formation, the most common size being $\cdot 6\text{--}\cdot 8\ \mu$ by $1\cdot 5\text{--}2\ \mu$. Involution forms are common, those formed in gelatine-colonies often of a curious curled-up shape.

No. 2. After three days at 25°C. a white film with dry and wrinkled surface is formed on top of the liquid. The film is easily

broken. The liquid remains clear, and a thin white deposit is formed in the flasks. On malt-extract-gelatine colonies are slowly formed, they are small, greyish-white, with a glistening surface. The bacteria have no motility and spore formation does not take place. It is rod-shaped, single or in chains, and very irregular in size, its most common dimensions being $.4-6\ \mu$ by $1-3\ \mu$. Large involution forms are common. It gives no coloration with iodine.

Its other characters are as follows :—

In bouillon (+1.5) after five days at 25°C . : thin film, liquid slightly cloudy, very little deposit.

On bouillon-agar : after seven days at 25°C ., small greyish, smooth-edged colonies of uncharacteristic appearance, the surface colonies slightly raised, not spreading. Deep colonies very small, spherical.

On bouillon-gelatine : colonies develop very slowly at room temperature. After 14 days they are very similar to the colonies on bouillon-agar. Non-liquifying.

Stab cultures on bouillon-agar after five days at 25°C . : flat, thin, leafy, spreading, whitish growth on surface. Streak filiform. Streak cultures similar to the surface-growth in stab-cultures.

On potato after seven days at 25°C . : a well developed growth with dirty-yellow raised streak in middle and white, spreading flat edges of irregular outlines.

In fermentation tubes : no gas is developed from glucose-, saccharose-, or lactose-bouillon. Acid is formed from glucose (4.2° normal per cent.), but not from saccharose or lactose. Nitrates are not reduced, and indol is not formed.

No. 3. After three days at 25°C . a white film with smooth surface is formed on the surface of the liquid. The film shows a tendency to creep up the sides of the culture-flask to a high degree, ascending in some cases to one inch above the liquid, which remains clear with a thin white deposit. On malt-extract-gelatine small, whitish colonies with transparent edges are slowly formed. The bacteria do not show motility or spore-formation, and are found single and in chains. The commonest dimensions are $.6-8\ \mu$ by $1.5-2\ \mu$, but there are also many larger rods. Involution forms are very common. No coloration with iodine occurs.

Its other characters are as follows :—

In bouillon (+1.5) after five days at 25°C . : thin film, liquid slightly cloudy, very small deposit.

On bouillon-agar : after seven days at 25°C ., well developed colonies, greyish white. Surface colonies spreading, flat with filamentous edges. Deep colonies as No. 2.

On bouillon-gelatine : see No. 2.

Stab cultures on bouillon-agar after five days at 25°C. : flat, thin, whitish growth with slightly raised undulated edges on surface, not spreading. Filiform streak. Streak cultures give a growth like the surface-growth in stab cultures.

On potato after seven days at 25°C. : rather feeble growth with thin, yellow midline and white spreading edges with irregular outline.

In fermentation tubes : as No. 2. Nitrates are not reduced, and no indol is formed.

No. 4. After three days at 25°C. a thin, white, ascending film with smooth surface is formed, and the liquid remains clear with a fine deposit. After some time the film sinks to the bottom of the culture-flasks, and no new film is formed. Colonies on malt-extract-gelatine are similar to No. 3, but without transparent edges. This bacterium is not motile, and no spore-formation has been observed. It is a very short rod, single or in long chains, its dimensions being about 1 by 1.5 μ . Involution forms are found but rarely. No coloration with iodine occurs.

Its other characters are as follows :—

In bouillon (+ 1.5) after five days at 25°C. : ascending well developed film, liquid slightly cloudy, very little deposit.

On bouillon-agar : After seven days at 25°C., surface colonies characterised with a white raised central point, spreading with slightly undulated edges, with a bluish tinge in transparent light. Deep colonies small, spherical, uncharacteristic.

On bouillon-gelatine : see No. 2.

Stab-cultures on bouillon-agar after five days at 25°C. : a flat, very thin, whitish growth, spreading over the whole surface. Streak filiform. Streak cultures like surface-growth on stab cultures.

On potato after seven days at 25°C. : no visible development.

In fermentation tubes : as No. 2 with the exception that the acid formed from glucose is a little lower (3.8° normal per cent.).

Nitrate and indol reactions as No. 2.

No. 5. This does not form a continuous film after three days at 25°C. ; only patches of a faint yellowish colour are floating upon the surface. The liquid is slightly cloudy, with a white, flocculent deposit. Very slow growth occurs on malt-extract-gelatine, where small colonies of a greyish-white colour with a dull surface are formed ; the colonies have a bluish tinge in transparent light. No motility nor spore-formation have been observed. The bacterium is a thin rod, mostly in chains, its dimensions being about .5 by 1-1.5 μ . Involution forms are very rare. No coloration is given with iodine.

Its other characters are as follows :—

In bouillon (+ 1·5) after five days at 25°C. : no film is formed, liquid hazy, with a small deposit.

On bouillon-agar : after seven days at 25°C., surface colonies raised, greyish-white, smooth-edged, non-spreading. Deep colonies very small, uncharacteristic.

On bouillon-gelatine : see No. 2.

Stab cultures on bouillon-agar after five days at 25°C. : small slightly raised whitish colony, with higher edges on surface. Streak filiform. Streak cultures characteristic, forming series of small, whitish, raised, isolated colonies.

On potato after seven days at 25°C. : a well developed brownish-yellow growth, raised, not spreading.

In fermentation tubes : as No. 2 with the exception that the acid formed from glucose is only 1 per cent. normal. Nitrate and indol reactions as No. 2.

The group-number of the four types = 222-23320.

Acid formation from Alcohol.—These bacteria were tested in relation to their power of forming acetic acid from alcohol. Culture-flasks containing sterilized malt-extract to which was added 3 per cent. of alcohol, were inoculated with the different bacteria in pure cultures and examined at intervals for increase of acetic acid. The flasks were kept at 25°C.

Bacterium	Percentage of Acetic Acid after					Per cent. alcohol left
	1 month	2 months	3 months	5 months	6 months	
No. 1 ..	·624	1·22	2·09	2·05	1·87	—
No. 2 ..	·522	·94	1·44	2·37	2·32	·19
No. 3 ..	·522	1·014	1·62	2·46	2·65	·26
No. 4 ..	·630	·954	1·54	2·16	1·93	·21
No. 5 ..	·384	·690	1·08	2·02	2·21	·16

Determination of Acid Formation in Cider.—The cider used was a blend of different kinds, and contained, after sterilization, ·46 per cent. of malic acid, 2·04 per cent. of alcohol (by weight), and had a specific gravity of 1·019. The flasks, each containing half a litre, were inoculated with the bacteria, and kept at 25°C.

Bacterium	Percentage of Acetic Acid after					Per cent. alcohol left
	1 month	2 months	4 months	5 months	6 months	
No. 1 ..	·624	·828	1·28	1·45	1·79	·05
No. 2 ..	·816	1·53	1·68	1·75	1·86	·11
No. 3 ..	1·476	1·584	1·92	1·98	2·046	·05
No. 4 ..	2·364	2·406	2·37	2·32	2·46	·10
No. 5 ..	1·554	1·590	1·69	1·74	1·782	·05

A series of similar cultures in the same cider were kept in a cellar with an average temperature of about 15°C.

Bacterium	Percentage of Acetic Acid after				
	1 month	3 months	4 months	5 months	6 months
No. 1 ..	·552	·606	·624	·660	·726
No. 2 ..	·306	·618	·648	·762	·798
No. 3 ..	·048	·594	·714	·822	·876
No. 4 ..	·042	·096	·114	·174	·174
No. 5 ..	·036	·108	·162	·198	·240

As will immediately be seen from the above tables, the temperature has a great influence upon the growth of the acetic acid bacteria, and the speed with which the alcohol is transformed into acetic acid. This is more pronounced in the case of some of the bacteria than with others. In the experiments with cider the bacterium No. 4, gives 2·364 per cent. of acetic acid after one month at 25°C., whereas the acid formed at cellar-temperature in the same time is only ·042 per cent., or 1·56th part of the amount produced at 25°C. Similar, although not so large, differences can be noted in the cases of the bacteria Nos. 3 and 5; but as regards Nos. 1 and 2 the influence of temperature upon the acid-forming properties is much less pronounced.

As regards the rapidity with which the oxidation of the alcohol into acetic acid takes place, it will be seen from the experiments with cider at 25°C. that there are very noticeable differences between the different types of bacteria. After one month No. 1 has formed ·624 per cent. of acid, whereas No. 4 has formed 2·364 per cent. in the same time and has, as a matter of fact, reached its maximum then; this is not the case with No. 1, which needs six months to attain its maximum production. At cellar-temperature the rôles are changed about, No. 1 producing ·552 per cent. of acid in one month and No. 4 only ·042 per cent., or less than 1·10th in the same time.

Acid formation from Sugars.—To try the influence of the acetic bacteria upon the different sugars, solutions containing 3 per cent. of cane-sugar, dextrose and lævulose, to which were added peptone and nutrient salts, were prepared, sterilized, and inoculated with the different bacteria. The flasks were left for three weeks at 25°C., and examined for acetic acid :—

Bacterium	Percentage of Acetic Acid in		
	Saccharose	Dextrose	Lævulose
No. 1 ..	0	·24	·024
No. 2 ..	0	·35	·018
No. 3 ..	0	·50	·006
No. 4 ..	0	0	0
No. 5 ..	0	·174	·012

As will be seen, acetic acid was formed in most cases from lævulose, and in larger proportions from dextrose, but all the experiments with cane-sugar were negative.

Effect of the presence of Organic Acids.—Some experiments were carried out to investigate the influence of different organic acids upon the development of the acetic bacteria. The acids used were malic, tartaric, citric and lactic acid. The acids were added in different proportions to cider, the mixtures were sterilized, inoculated with the bacteria Nos. 1 and 4 and placed at room-temperature :—

Content of Acid per cent.	Percentage of Acetic Acid present after 2 months.		Percentage of Acetic Acid present after 3 months.	
	Bacter. No. 1	Bacter. No. 4	Bacter. No. 1	Bacter. No. 4
No. 1 .. .32 Malic acid ..	1.80	.63	1.86	1.09
No. 2 .. .45 " " ..	1.54	.93	1.93	1.10
No. 3 .. .67 " " ..	1.40	.92	1.81	1.12
No. 4 .. .84 " " ..	2.09	.85	2.15	1.0
No. 5 .. 1.03 " " ..	.054	.19	1.25	.24
No. 6 .. .49 Tartaric acid	1.94	.51	2.08	.67
No. 7 .. .66 " " ..	2.10	.22	2.28	.31
No. 8 .. .85 " " ..	2.22	.08	2.33	.20
No. 9 .. 1.01 " " ..	.24	.10	.26	.12
No. 10 .. .44 Citric acid ..	1.08	1.09	1.2	1.21
No. 11 .. .63 " " ..	1.78	.94	1.94	1.11
No. 12 .. .78 " " ..	2.44	2.42	2.59	2.62
No. 13 .. 1.00 " " ..	1.46	1.89	1.72	1.99
No. 14 .. .50 Lactic acid ..	.03	.21	.29	—
No. 15 .. .72 " " ..	.04	.21	.28	—
No. 16 .. .93 " " ..	.042	.39	.49	—
No. 17 .. 1.06 " " ..	.048	.39	.45	—

The cider used was the same for all the experiments, and contained originally .32 per cent. of malic acid ; consequently .32 has to be subtracted to find the quantity of acid added in all the figures relating to tartaric, citric, and lactic acid in the table.

It will be seen from the figures that only relatively large quantities of acid have any inhibitory action upon the development of the bacteria in the cases of malic and tartaric acid. In the flask with bacterium No. 1, containing the highest percentage (1.03) of malic acid, (No. 5), only .054 per cent. of acetic acid was formed after two months ; whereas the culture (No. 4), with .84 per cent. of malic acid contained 2.09 per cent. of acetic acid after two months. Similar proportions in a less pronounced degree are found in the experiments with tartaric acid (Nos. 8 and 9). The citric acid does not seem to have much retarding action in the proportions used, as will be seen by comparing Nos. 12 and 13. On the other hand even relatively small amounts of lactic acid act as a preventive against the development of the acetic acid bacteria. By looking through the figures in Nos. 14 to 17 it will be found that only very

small quantities of acetic acid were produced in two months in comparison with the control (No. 1).

Oil as a Preventive Against Acetification.—A series of experiments has been carried out with thin layers of oil on the surface of cider to prevent the access of air, and, consequently, acetification. The oil or, to be more correct, oily substance used was in all cases liquid paraffin.

In the first instance flasks containing cider covered with a layer of liquid paraffin were sterilized and inoculated with the five types of acetic bacteria. The cider used had, after sterilization, a specific gravity of 1·019, and contained ·46 per cent. of malic acid, and 2·66 per cent. of alcohol. The inoculated flasks were placed at 25°C., and examined for the first time after one month. The result of the examination was that the acidity in the five flasks was the same as in the non-inoculated control sample. No acetic acid had been formed. All the flasks showed a very good development of the bacteria, with the usual films on the surface of the cider under the oil-cover. The flasks were examined after two months, with very nearly the same results, and it was not until after three months' keeping at 25°C. that small quantities of acetic acid were developed. No. 1 then contained ·08 per cent. of acetic acid, No. 3 ·036, and the three others only a feeble trace.

To ascertain the thickness of the oil-layer necessary to prevent acetification twelve flasks, each containing $\frac{1}{2}$ litre of cider, the surface of which was covered with layers of oil of different thickness, were sterilized and all inoculated with *Bacterium xylinum* except one, which was kept as a control. The cider used gave, after sterilization, the following analysis: specific gravity 1·013, malic acid ·38 per cent., alcohol 2·72 per cent. The flasks were kept at room-temperature during the summer-months and examined after two, three, and four months. The bacteria developed well in all flasks, and there was no visible difference between the growth in the control-flask and in the flasks covered with a layer of oil. The results of the examination for acetic acid were as follows:—

Flask No.	Liquid Paraffin added per square inch of surface.	Height of layer in inches.	Percentage of Acetic Acid present after		
			2 Months.	3 Months.	4 Months.
0 (Control)	0		1·72	1·78	1·84
1	·05 ccm.		1·14	1·20	1·23
2	·10 "		·87	·91	·97
3	·15 "		·81	·84	·85
4	·20 "		·81	·85	·85
5	·25 "	1/64th	·60	·63	·70
6	·50 "	1/32nd	·50	·54	·58
7	1·00 "	1/16th	·30	·33	·36
8	2·00 "	$\frac{1}{4}$	·096	·18	·19
9	4·00 "	$\frac{1}{4}$	·054	·09	·15
10	6·00 "	$\frac{3}{8}$	·030	·058	·078
11	8·00 "	$\frac{1}{2}$	·022	·036	·060

According to the above results, the formation of acetic acid is in inverse proportion to the thickness of the layer of liquid paraffin. The thicker the layer the less the production of acetic acid : and if the layer is one-fourth of an inch or more in thickness the acetification is negligible for practical purposes.

The experiment was repeated upon a larger scale. Three 6-gallon casks were filled about two-thirds full with the same cider. Cask No. 1 was closed with a bung in the usual way. On the surface of cask No. 2 was poured so much liquid paraffin that it formed a layer of about three-eighths of an inch thickness. Cask No. 3 was connected with a steel cylinder, containing liquid carbonic acid gas. All the casks were placed in a fairly warm room, and once a week a certain quantity of cider was drawn off through an inserted tap, each time letting the necessary air into Casks Nos. 1 and 2, whereas in No. 3 the cider was replaced with carbonic acid gas.

The casks were examined for acetic acid from time to time and the analyses gave the following results :—

	Percentage Acetic Acid present after					
	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
Cask No. 1	·10	·25	·39	·54	·70	·76
" " 2	·04	·04	·05	·06	·06	·06
" " 3	·07	·10	·15	·16	·18	·18

In cask No. 1 the cider acetified rapidly, and became quite undrinkable after six weeks. In the case of cask No. 2 hardly any acetic acid was formed, and the cider was just as good at the end as at the beginning of the experiment. Cask No. 3 had a distinct acetic flavour after six weeks, but was much superior to No. 1.

The practical conclusions to be drawn from this investigation are that acetic bacteria are invariably present in ciders made under ordinary conditions, and that acetification will occur during storage in cask at normal or high temperatures unless special precautions are taken. Of these the simplest appears to be to cover the surface of the liquor with a layer of liquid paraffin or a tasteless and odourless oil, at least $\frac{1}{4}$ inch in depth. Slightly less efficient is the method of keeping the cider charged and covered with carbonic acid gas. The inhibitory action of lactic acid on the development of the acetic bacteria needs further investigation, since it may be found that by encouraging a slight lactic fermentation in cider the disorders of acetification and, perhaps also, of sickness and ropiness may be controlled without serious detriment to the flavour of the liquor.

THE PASTEURIZATION OF BOTTLED CIDER.

BY OTTO GROVE.

One of the greatest drawbacks with ordinary bottled cider is its uncertain keeping qualities. To some extent the difficulty can be overcome by selecting a cider of a suitable composition, a fairly high acidity being especially desirable, and also by bottling at the right moment. But even with the greatest care it is often found that after some time the bottled cider turns cloudy, develops "flyers," or undergoes other transformations. Practically all the disorders in bottled ciders are due to the development of some kind of living organism, either yeasts, bacteria, or moulds. Generally a very slow fermentation is considered desirable in the bottle, so as to keep the cider in a sparkling condition; but very often too much fermentation takes place and too large a deposit of yeast cells is formed, the cider losing the clear and brilliant appearance which is mostly required by the consumer.

In pasteurization, as it is commonly practised with many bottled liquids, *e.g.*, beer, milk, wine, and others, the filled and closed bottles are placed in suitably constructed water-baths, and the water is slowly heated to such a temperature that the living organisms present in the contents of the bottles are either killed or so much weakened in their vitality that their development is checked for a certain time. The temperature and the time of exposure vary according to the different liquids under treatment. The temperatures generally range between 140° and 180°F., and the time of exposure between five and thirty minutes. In the pasteurization of cider it is impossible to use such high temperatures, because of the cooked flavour which results: and, therefore, as will be seen from the experiments described below, much lower temperatures have been used, at the same time prolonging the time of exposure. By this method the cooked flavour does not appear to a serious extent.

It is evident that if the cider is to be sparkling after the pasteurization, it is necessary to charge it with carbonic acid gas before bottling, since no yeasts can develop in the bottles afterwards and, therefore, no fermentation and natural development of gas can

take place. In the present experiments some of the cider was charged with carbonic acid gas and bottled at a pressure of 15lbs. ; in some later experiments a pressure of 30lbs. was used.

It is necessary to use large corks of a good quality, and to wire them carefully. If the corks are inferior, the pressure created in the bottles by the rise of the temperature will force the gas out between the cork and the neck of the bottle. It is best to use paraffin-waxed corks.

The ciders used for the experiments were blends of different single variety ciders.

Blend No. 5 was made in the end of March, 1915, from nine different ciders, all filtered in the beginning of the year. The blend when used for the pasteurizing experiments in June had a specific gravity of 1.010, and contained .41 per cent. of malic acid.

Blend No. 8 was made in April, 1915, from twelve different filtered ciders. It had a gravity of 1.010, and contained .36 per cent. of malic acid.

Blend No. 4 was a mixture of Kingston Black and Cap of Liberty ciders. It had a specific gravity of 1.020, and contained .65 per cent. of malic acid.

At the time of bottling the blends were not quite clear, as they had been in cask for over two months, and some fermentation had taken place. A microscopical examination showed plenty of living yeast-cells and some bacteria in all of them. This was considered an advantage in this connection, as it made the pasteurizing experiments more conclusive than would have been the case if the ciders had been brilliantly clear and consequently contained few organisms.

The experiments were carried out in the following way. After the bottles had been corked and wired they were stacked upon their sides in a large metal vessel, which was filled with cold water so that the bottles were well covered. The water was then slowly heated with steam, 30—40 minutes being taken to raise the temperature to the desired point. When the bottles had been kept as long as required at the pasteurizing temperatures they were taken out of the hot water, and left to cool.

The bottles of the three blends, both carbonated and uncarbonated, were kept at the following temperatures: A. at 45°C. (113°F.) for one hour; B. at 50°C. (122°F.) for half an hour; C. at 50°C. (122°F.) for one hour; D. at 55°C. (131°F.) for half-an-hour.

After pasteurization they were all kept for two months together with non-pasteurized control bottles before examination. The results were as follows:—

BLEND 4 (Uncarbonated).

Control: fairly large deposit.
A, B, C and D. Small deposit.

BLEND 5 (Uncarbonated).

Control: fairly large deposit, many
"flyers."
A. Ditto.
B. Very little deposit.
C. Ditto.
D. Ditto.

BLEND 8 (Uncarbonated).

Control: some deposit.
A. Small deposit.
B, C and D. Very little deposit.

BLEND 4 (Carbonated).

Control: fairly large deposit.
A, B, C and D. Small deposit.

BLEND 5 (Carbonated).

Control: rather large deposit.
A, B, C, D, hardly any deposit.

BLEND 8 (Carbonated).

Control: small deposit.
A. Ditto.
B, C and D. Very little deposit.

The small deposits in the pasteurized samples, B, C and D, were due to the cider not being quite clear at the start of the experiment. No new development of organisms had taken place as was the case with the controls. In no case could a marked cooked flavour be detected. The uncarbonated samples were, of course, quite still, whereas most of the carbonated were sparkling, with the exception of some cases where the corks were defective.

To find out whether any living organisms were present after the pasteurization samples were taken aseptically from the deposits and introduced into small culture-flasks containing sterilized malt-extract. The flasks were placed in the incubator at 25°C. and examined after twenty-four hours, and again after two days and seven days, with the following results:—The flasks with the samples from the deposits and liquids in the controls and the A. samples (kept for one hour at 113°F.) gave a vigorous fermentation and development of yeasts, torulæ, and bacteria after two days. The flasks inoculated from the deposits and liquids in the B, C, and D samples (kept at 122°F. and 131°F.) remained sterile after seven days. This indicates the possibility of pasteurizing ciders at low temperatures, *e.g.* 125° to 130°F., without altering their flavour seriously, provided that the ciders contain a certain amount of acidity (.4 to .6 per cent. of malic acid), and that the bottles are kept at the mentioned temperature for a sufficiently long time, *i.e.*, one hour or more.

In connection with these pasteurizing experiments, the influence of a prolonged exposure to similar temperatures was tried upon vigorous cultures of some of the most common bacteria causing disorders in cider. The bacteria used were *Bacterium xylinum*, Acetic Bacterium No. 4, and the sickness bacillus. Young cultures

of the bacteria were kept at the different temperatures, and afterwards transferred to flasks, with a nutrient medium, which were placed in the incubator. These new cultures were examined after three days, six days, and fourteen days, the results being as follows :

Cultures at 50°C. for thirty minutes : After fourteen days all the flasks with sickness-bacillus and bacterium No. 4 showed development. No development in the flasks with *Bacterium xylinum*.

Cultures at 50°C. for one hour : Same result as above. Consequently the exposure to a temperature of 50°C. for one hour was not sufficient to kill the sickness bacillus or the bacterium No. 4. Only *Bacterium xylinum* succumbed.

The experiments were repeated, using the same media (yeast-water and 5 per cent. glucose) but adding .1, .2, .3, .4 and .6 per cent. of malic acid to test the influence of temperature and acidity combined. It was found that an exposure to 50°C. for one hour in a liquid containing .3 per cent. or more of malic acid was in all cases sufficient to kill the sickness bacillus and *Bacterium xylinum*, whereas under the same temperature conditions Bacterium No. 4 was only killed when the liquid contained .6 per cent. of acid. It must be remembered that the bacteria were cultivated in a medium which was especially favourable for their development, and that young and very vigorous cultures were used. Similar favourable conditions do not exist in cider.

It appears, therefore, that an efficient pasteurization of bottled cider can be effected without serious harm to flavour by exposure to a comparatively low temperature for a sufficiently long period. The comparatively slight alteration in flavour which is produced, would probably be passed without notice by the average consumer who was not a connoisseur of cider : and, on that account, the method, even as it stands after so short an investigation, may be recommended for trial to bottlers of cider who regularly experience trouble with cider sickness and other disorders. It is quite possible, however, that this slight flavour drawback may be overcome, since there is already reason to anticipate that, after long standing in bottle, the treated cider will lose the greater part, if not the whole, of the acquired flavour.

EXPERIMENTS WITH CLEARING AGENTS FOR THE CONTROL OF FERMENTATION IN CIDER.

BY OTTO GROVE.

A few preliminary experiments have been made with the object of finding, if possible, a suitable substitute for the filter as an agent to stop fermentation when desired. The action of the filter is to remove the yeast-cells from the cider, thereby checking or, in many cases, very nearly stopping the fermentation. It is very improbable that a medium to separate the yeast-cells from the cider to the same extent as is possible by using a good filter will be found; but where no filter is available a substitute would be of value, if, when added in certain proportions to the cider, it could precipitate the yeast-cells suspended in the liquid so as to make them form a deposit from which the clear cider could be racked.

The experiments were carried out with a juice made from Lambrook Pippin apples. The juice had a specific gravity of 1.044, and contained .50 per cent. of malic acid, and .18 per cent. of tannin. The juice was filled into large glass jars, each containing eight litres. The jars were closed with a fermentation trap and allowed to ferment until the specific gravity had fallen to 1.029. The liquid in all the flasks, except one kept as a control, was then syphoned from the deposit into slightly smaller flasks, and the addition of the clearing media was made in the proportions mentioned below, these having first been found by preliminary experiments upon a small scale to give the best clearing.

No. 1	(Control).			
No. 2	Racked.			
No. 3	5 grams of Gelatine added ..	..	per 100 litres.	
No. 4	40 grams Phosphate of Calcium ..	..	..	..
No. 5	10 grams Caseine ..	..	..	..
No. 6	2 whites of egg ..	..	..	..
No. 7	2 grams of Tannin and 4 grams of Gelatine ..	..	..	..
No. 8	Apple-pectin ..			
No. 9	5 grams of Isinglass ..	..	..	..
No. 10	300 grams of Kaolin ..	..	..	..
No. 11	Filtered.			

The flasks were kept at room temperature for some time, and from each some bottles were filled.

At the time of bottling :

Sample No.	1	had a specific gravity of 1.017, not quite clear ; very large, loose deposit.
„	No. 2	„ „ „ 1.024, very nearly clear ; thin hard, deposit.
„	No. 3	„ „ „ 1.025, not quite clear ; large, loose deposit.
„	No. 4	„ „ „ 1.024, very nearly clear ; thin hard deposit.
„	No. 5	„ „ „ 1.027, not clear ; fairly large, loose deposit.
„	No. 6	„ „ „ 1.019, very nearly clear ; large, loose deposit.
„	No. 7	„ „ „ 1.023, very nearly clear ; large, loose deposit.
„	No. 8	„ „ „ 1.028, very nearly clear ; fairly large, very loose deposit.
„	No. 9	„ „ „ 1.016, not clear ; fairly large, loose deposit.
„	No. 10	„ „ „ 1.018, very nearly clear ; fairly large, hard deposit.
„	No. 11	„ „ „ 1.025, perfectly clear ; very little deposit.

After three months the bottles were examined, with the result that, with the exception of the filtered sample, they were all cloudy with large deposits, too much fermentation had taken place, and the cider had lost most of its sweetness. Only the filtered sample remained clear, with very little deposit and a drop in specific gravity of not more than three points.

The results thus demonstrate the very great superiority of the filter over the other agents employed to separate the yeast and stop fermentation, and also the difficulty of adequately controlling fermentation without it, assuming that no preservatives are used.

FURTHER FERMENTATION EXPERIMENTS WITH PLUM JUICE.

BY OTTO GROVE.

The experiment mentioned in last year's report to make a kind of wine from the Pershore egg-plum was repeated upon a larger scale during 1915.

The plums were made up in the following way : 650lbs. of plums were passed through the grater cider mill, which had been arranged so as to leave a passage of about $\frac{1}{2}$ inch between the drum with the grating knives and the counter-weight. The plums passed through very rapidly, and although a certain amount went through without breaking the stones, probably half of the stones were broken, but as a rule not completely ground up, so that in most cases the kernels came through entire. Too many broken kernels would probably make the wine bitter. The grated plums were put into an open tub and to them were added 30 gallons of water in which previously 56lbs. of sugar had been dissolved. The whole was thoroughly mixed, and an average sample taken out for analysis. The juice had a specific gravity of 1.051, and contained .79 per cent. of acid, and 12.5 per cent. of total sugar.

The mixture was left for two days in the open vessel, with a disc of wood resting on the surface, so as to prevent the crushed plums from rising to the top. The whole was stirred up several times during the maceration. The fermenting mass was then pressed in the usual way with a cider press, and the juice was collected in a cask and left to ferment in the cellar at a temperature of about 60°F. The yield of juice was 64 gallons.

Fermentation was very vigorous, and only six days after pressing the specific gravity had fallen to 1.028, and the juice was filtered. It came through the filter completely clear, and was put into a cask. Fermentation started again, and it was necessary to filter a second time six weeks later, when the specific gravity had fallen to 1.012.

The resulting wine lacks body, but has a pleasant, clean, and brisk flavour, with a pronounced taste of the plum. It keeps very well, and at the time of writing, five months after making, it is perfectly clear, with a little deposit, has a specific gravity of 1.011, and contains .56 per cent. of acid and 4.12 per cent. of alcohol. Although at present a definite commercial value could not be placed upon it, there seems a reasonable prospect for anticipating that a beverage of this kind could be turned to profitable account.

THE COMPOSITION OF VINTAGE APPLE AND PEAR JUICES, 1915-16.

BY B. T. P. BARKER AND OTTO GROVE.

In order to limit the length of the Report this season, the usual tables showing the analyses of all the apple and pear juices made during the season are omitted. So far as the varieties of vintage fruit obtained for the cider-making experiments are concerned, the analyses of their juices will appear in the next Annual Report with the description of the ciders themselves. The analyses of the fruit from the various trees under experimental treatment at the Station will be dealt with in due course when the results of the methods of treatment of those trees are dealt with. The only details, therefore, which will be published on this occasion are those of vintage varieties which were sent in for analysis only. These are given in the following table.

It will be noticed that the results in these cases show a tendency for the gravities to be on the low side. This is a feature which has been most marked throughout all the analyses made during the season. In very few cases has a higher gravity than 1.057 been obtained; the great majority of the juices show gravities below 1.050, and some below 1.040. These figures are much below the normal, and it is clear that the season's juices must be considered as seriously deficient in sugar. In several cases the rates of fermentation have been fairly low; so it has been possible to retain a moderate amount of sweetness in the ciders. The latter at present are softer in character than those of the previous season, but much less full-bodied. The acidity of the juice in most cases is not far removed from the normal. On the whole it is probably slightly below the average. The percentage of tannin again is somewhat below the average in most of the varieties analysed.

The 1915-16 juices as a whole, therefore, must be considered as of a watery type, which is interesting considering that the amount of rainfall during the summer of 1915 was not excessive, and that there was a fair amount of sunshine. Possibly the carbohydrate reserves of the trees were depleted by the heavy crops of 1914, and the quality of the 1915 fruit suffered in consequence.

Name of Variety.	Specific Gravity of Juice.	Percentage Composition of Juice.			Rate of Fermentation.	Grower.	District.
		Total Sugar. Approximate.	Malic Acid.	Tannin.			
APPLES.							
BERKELEY PIPPIN	1.048	9.5—11.5	.15	.15	9	J. Wyatt ..	Claverham
BROCKLEY GILLFLOWER	1.050	10—12	.24	.09	..	J. Hawkins ..	Brockley
BROCKLEY SEEDLING	1.048	9.5—11.5	.80	.32	8.6	Ditto ..	Ditto
COWARNE RED ..	1.050	10—12	.34	.16	3.5	W. Crump ..	Madresfield Court,
DYMOCK RED	1.057	11.75—13.75	.26	.12	10.2	Harper Adams Coll.	Malvern
FOXWHELP	1.047	9.25—11.25	.77	.23	5.7	W. Crump ..	Newport, Salop
KINGSTON BLACK	1.050	10—12	.42	.16	4.8	J. Hawkins ..	Madresfield Court,
LORD HINDLIP	1.051	10.25—12.25	.20	.12	10	Ditto ..	Malvern
MEDAILLE D'OR	1.054	11—13	.19	.96	4.2	Harper Adams Coll.	Brockley
NEVERBLIGHT	1.039	7.25—9.25	.40	.20	7.8	Ditto ..	Ditto
PASSE REINE DE POMME	1.049	9.75—11.75	.24	.34	5.2	J. Hawkins ..	Newport, Salop
SEEDLING	1.057	11.75—13.75	.19	.19	5.7	H. C. Hancock	Brockley
Ditto	1.054	11—13	.32	.17	4.3	Ditto ..	Milverton
Ditto	1.053	10.75—12.75	.38	.11	5.1	Ditto ..	Ditto
Ditto	1.050	10—12	.09	.20	5.8	R. H. Cazalet	Malvern
Ditto	1.058	12—14	.65	.47	5.4	J. Marshall	Wraxham
Ditto	1.057	11.75—13.75	.28	.26	5.6	J. Hawkins ..	Brockley
SWEET ALFORD..	1.056	11.50—13.50	.11	.16	5.1	W. Crump ..	Madresfield Court,
Ditto	1.057	11.75—13.75	.17	.22	5	Ditto ..	Malvern
SUSSEX FORGE APPLE	1.042	8—10	.50	.12	2	M. Chart ..	Ditto
PEAR.							Crawley, Sussex
OLDFIELD	1.045	8.75—10.75	.31	.06	6.8	Harper Adams Coll.	Newport, Salop

NOTES ON THE PECTINS OF CIDER APPLES AND THEIR USES.

BY B. T. P. BARKER.

The chemical composition of the apple has from time to time been extensively investigated. It is, however, the case that although certain aspects of the question, concerned mainly with the sugars and acids of the fruit, have been well studied, comparatively little is known as to its composition in respect of some of the other constituents. Many analyses of different kinds of apples and their juices have been made by various workers, both in this country and abroad; but the majority relate to cider fruit, and are concerned chiefly with the quantities of sugar, acid, and tannin present, these being the substances of primary importance for cider-making. Thus several thousand analyses of this kind have been made at the Institute since its establishment in 1904; but while they have furnished much information as to the normal composition of English vintage apples and its variation owing to seasonal and other factors, they do not deal with any constituents other than those mentioned. Included among the comparatively neglected constituents is the group of substances which may be classed together under the general name of pectins.

The pectins, which are closely associated with the cellulose of the walls of the cells of the fruit, and are believed to serve largely, if not exclusively, as the cementing material which binds the walls of the individual cells together, are bodies which are generally regarded as carbohydrates or related substances and can ultimately be converted into a form of sugar, probably identical with arabinose. On account of their general physical character and of their tendency to form compounds of a gelatinous nature, they are sometimes referred to as the mucilaginous elements of the fruit: and they are the cause of the semi-viscid or slimy condition of the pulp of an apple, familiar to anyone who has handled one in an over-ripe state.

These substances are important constituents of the apple in several connections. As carbohydrates or related substances, they may possess definite food value. In the jam-making industry their value is well recognised on account of their property of assisting jam to set or "gel" firmly. Similarly, in the making of apple jelly it is these bodies which cause this article to set. In cider-making they

are sometimes of considerable assistance and on other occasions cause much trouble. The phenomenon of "dropping bright," of which most cider-makers have at one time or another had some experience, is undoubtedly associated with certain changes taking place in the pectin constituents of the juice. In many ciders, bottled comparatively early in the season, troublesome light flocculent deposits are formed. These, again, are probably associated with pectin changes.

During the course of the work on the making of cider apple jelly, the method for which was given in last year's Report, it became evident that, while the pectins of the apple juice caused the formation of the jelly, they could not be relied on in all cases to give the same kind of result when a uniform method of making the jelly was adopted. Sometimes a good jelly was produced. In other instances a thin semi-liquid jelly resulted. Occasionally the concentrated juice failed entirely to set. In such examples it was found that when an extract of apple pomace, prepared by boiling it with a limited quantity of water or apple juice for some time, was added to the juice which would not set, the latter would, after a little further boiling, form a firm jelly. Even, however, when this pomace extract was used, the results were not entirely uniform. An investigation of the pectins of the apple was, therefore, started, and is now proceeding. Since the work is still far from complete, it is not proposed to deal here with it in detail: but a summary of some of the more interesting points bearing on practical questions arising in the making of jam and fruit jellies and of cider is given.

The three principal objects of the investigation were to obtain knowledge of the pectins of the apple and their changes during the ripening of the fruit, to determine the parts played by them in causing the setting of jams and jellies, and to ascertain more exactly their history and fate during the making of cider. In addition, there was the possibility that a pectin-containing product might be prepared from pressed apple pomace, which might prove of service in the jam-making and cider industries.

So far as the pectins themselves are concerned, they are generally regarded by bio-chemists as being derived in the first instance from an insoluble substance, pectose, which is produced in young plant tissues in association with cellulose. Pectose, in the course of the development of these tissues, apparently undergoes changes leading to the formation of two classes of substances. One class, pectine and its derivatives, is neutral in character: and the other, a series of pectic acids, is slightly acidic, and forms gelatinous insoluble salts with various bases. Since both in jam-making and in cider-making one is concerned ultimately only with soluble forms of pectin, either in the juice or in an aqueous extract of the fruit pulp, reference will be confined here solely to those forms.

THE FORMATION OF GELS BY PECTINS.

On the addition of an excess of strong alcohol to freshly pressed apple juice or to an aqueous extract of apple pulp a gelatinous precipitate is formed. The amount of this precipitate probably represents the quantity of pectins in the original liquid. If the aqueous extract contains much pectin, the addition of the alcohol causes the whole to set in a semi-solid gelatinous mass. After filtration and the removal by pressure of the alcohol retained by the gelatinous mass, this substance is found to be more or less readily soluble in water. The addition of an excess of caustic soda to its aqueous solution produces a bulky gelatinous precipitate, or, if the solution is strong enough, the mixture forms a firm jelly. Ammonia added to a strong aqueous solution sometimes causes the latter gradually to set to a jelly; but the results in this direction have been variable. A concentrated solution of ammonium sulphate also precipitates the pectin from strong aqueous solutions in the form of a jelly. Solutions of salts of the heavier metals give gelatinous precipitates. Acetone precipitates the pectins from aqueous solutions in the same manner as alcohol.

The soluble pectins of the apple thus yield products of a gelatinous character readily and rapidly with the aid of a variety of chemical reagents: and the question arises as to whether the setting of jams and jellies is brought about by actions of that type, or whether it is merely due to the concentration of the pectins of those articles by the boiling to which they are subjected.

The composition of a jam is, relatively, simple, consisting primarily of the sugar of the fruit plus the added sugar,—making, in all, about 60–70 per cent. of sugar—the fruit acids, equivalent to about 1 per cent. tartaric acid, the fruit pectins, and the insoluble cellulose and other residual elements of the fruit tissues. The latter bodies may probably be ruled out of account, so far as the gelling phenomena proper are concerned, because of their insolubility. Fruit jellies are of substantially the same composition as jams with the omission of the insoluble elements.

The gelling of jams and jellies is presumably due either to the concentration and possible chemical changes of the pectins resulting from the boiling, or to the action of the sugars or acids, or of both in combination, on the pectins. The former alternative, which at first sight may seem to be the more likely, appears to be definitely disproved by the fact that the pectin extracts of apple pulp do not gel, however far they may be concentrated by boiling. It is possible by concentration of aqueous pectin extracts under suitable conditions to obtain the pectins in solid form, but at no time during concentration does the extract approach a true gel in character, remaining throughout a more or less viscous fluid. The action of various sugars in combination with pectin extracts has been examined.

Here, again, no true gel resulted either before or after boiling, whatever the proportions of sugar and pectin used. The invariable result was a viscous syrup. Various fruit acids, such as tartaric, citric and malic, were then tested similarly with the pectin extracts. In no case was a gel produced. An entirely different result was, however, obtained when the effect of sugar and acid in combination was tested. Solutions of pectin, to which sugar, (either dextrose or cane sugar), was added at the rate of 60-70 per cent., were boiled for a few minutes, and then tartaric acid at the rate of 1 per cent. was also added and the mixture re-heated. In a few moments the first signs of gel formation became apparent, and on standing for a short time the mixture quickly set to a firm jelly. The same type of experiment has been frequently repeated since in various forms, and invariably the result has been similar. It seems clear, therefore, that the gel formation in the making of jams and fruit jellies is caused by the joint action of the fruit acids and sugars on the pectins.

That being the case, the fact that sometimes jams and jellies fail to set, although made apparently under the same conditions as successful ones, requires explanation. The example of certain types of cider apple jelly, referred to above, which set on addition of pomace extract but would not do so without it, suggests that in some cases at least the fault in the original mixture may be insufficient pectin. A lack of pectin in the finished article can result from a variety of causes. There may be a deficiency of pectins in the fruit at the start: or, since pectins probably undergo considerable changes in character during the course of ripening of the fruit, the types of pectin present may be unsuitable for gel formation under the conditions of jam-making. Then, again, while suitable pectins in sufficient quantity may be present at the outset, decomposition or precipitation may occur during boiling. There is good reason to suppose that each of these possibilities occurs from time to time in practice owing to some slight variation from standard conditions which, owing to the present limited knowledge of the subject, may have escaped detection.

As already stated, however, the addition of pomace extract to concentrated apple juice does not invariably cause it to gel: and in such instances the failure cannot be attributed to lack of pectins, unless, indeed, those in the pomace extract are precipitated at the time of addition. This possibility doubtless occurs occasionally: but cases have come under observation where there was no sign of precipitation. The failure to gel must, therefore, in some instances, be due to other causes. Many experiments on this point have been made, and some very interesting results recorded. Detailed reference to this part of the work would occupy too much space here, and further investigation is also necessary. The main conclusion

thus far reached is that in a comparatively complex mixture of substances, such as a concentrated fruit juice, a certain balance between sugars, acids, and pectins, is necessary to obtain a complete gel. There is a minimum quantity of each of those substances which must be present, if a gel in any form is to be produced. The increase of either constituent above that minimum quantity without a corresponding increase in the amount of the others *may* result in a failure to gel properly, this depending on the extent of the increase. If all constituents are increased proportionately, the gelling character is retained unimpaired; and in such cases the greater the increase up to a certain point the stiffer is the gel.

Before passing from this part of the subject it may be mentioned that it has quite recently been found possible to produce these gels from sugar—acid—pectin mixtures without the aid of heat. This fact opens up a number of interesting possibilities in connection with the use of apple pectin for a variety of purposes. Another fact of interest discovered is that glycerine, which is chemically a very simple form of sugar, can be used in the place of other sugars for these gel productions.

“DROPPING BRIGHT” IN CIDER.

Since in freshly pressed apple juice there is a mixture of sugars, malic acid, and pectins, the possibility of their interaction to produce the jelly-like clot which is the precursor of “dropping bright” in cider, suggests itself. In the Annual Report for 1904 the subject of “dropping bright” was briefly dealt with, and it was there shown that the phenomenon was caused by changes in the pectins in solution in the apple juice, which resulted in the formation of a jelly-like clot and a mechanical clearing of the liquor thereby. Mainly from analogy with somewhat similar pectin changes in other plant juices and extracts, which had been more extensively investigated, it was concluded that the conversion of the soluble pectins of the apple juice into the insoluble gelatinous form was effected by the action of pectase, a special type of enzyme, which has the power of converting some of the soluble pectins into insoluble gels in neutral or very slightly acid liquids. Its action is inhibited if the acidity is appreciable. This interpretation corresponded well with the facts at that time available, since “dropping bright” in that form had been observed only in the cases of juices from sweet and bitter-sweet varieties of apples, the acidity of which is normally very low. Since that time, however, other types of “dropping bright” and gel formation in ciders and perries have been met with, chiefly in cases where the acidity was sufficiently high to make it improbable that pectase action was responsible.

It seemed desirable, therefore, to make a further investigation of the subject in the light of the better knowledge of the pectins now available. This work has not yet been completed: but it has been carried sufficiently far to prove that there has been present in the juices already examined sufficient pectase to cause the "dropping bright" phenomena when the acidity was low enough naturally, or when it was reduced to the necessary degree by partial neutralisation with calcium carbonate. The addition of a small proportion of freshly pressed apple juice, or a few particles of pomace, to crude pectin extracts obtained from pressed pomace caused these to set to a firm jelly within twenty-four hours at 25°C., when the mixture was completely neutralised with calcium carbonate. Similarly the addition of limited quantities of such extracts to freshly pressed apple juices produced "dropping bright" in the latter, when the acidity was sufficiently reduced. It seems evident, then, that pectose plays a part in the "dropping bright" of ciders of low acidity. In the other types of "dropping bright," where the acidity is relatively high and pectase action on that account presumably negligible, the sugar-acid-pectin interaction may have to be taken into consideration. The possibility that another enzyme is concerned, acting in a corresponding way to pectase, but working in a high acid medium instead of a low acid one, must be borne in mind. At present, owing to the infrequency with which these types occur, it has not been possible to obtain definite evidence either way.

"DROPPING BRIGHT" IN PERRY.

A peculiar form of "dropping bright" in perry has been rather more completely investigated. This type, which is probably familiar to all makers of perry working with pears of the Oldfield class, is most frequently seen in bottled perry, although it occurs also in perry in cask. The usual manner of its development is as follows. The liquor, perfectly clear when bottled, gradually becomes hazy, and in due course densely turbid, resembling at that stage in appearance and colour a milky fluid. Later, a complete natural clearing takes place, the substance causing the milkiness being gradually deposited in the form of an opaque, cream-coloured, jelly-like crust on the sides and bottom of the bottle. The liquor eventually is left in perfectly brilliant condition. The nature of the crust strongly suggests at first sight that it is a pectin compound; but at present none of the ordinary pectin reactions have been obtained with it. On the other hand, the crust gives to a marked degree certain reactions which are characteristic of the tannins which occur in perry pears; and it must be concluded that in this case it is this group of substances which is responsible for the "dropping

bright." This result corresponds with those of Kelhofer, who, working with certain Swiss-grown varieties of pears, observed a series of changes in their juices which closely resembled some of the "dropping bright" phenomena here referred to, and traced them to the action of the pear tannins. Further reference to this subject will be made in a later report.

PECTIN PRODUCTS FROM CIDER APPLE POMACE.

From what has now been stated, some idea can be formed as to the importance of the pectin group of substances in the making of both jam and cider. It appears highly probable that, if certain of the apple pectins could be extracted from the fruit in a fairly pure form, they could be utilised with advantage in the jam and cider industries, and, perhaps, also in certain other directions. Every year large quantities of pressed cider apple pomace are produced in this country, and in many cases so little use is made of it that it is practically a waste bye-product. It contains considerable quantities of the pectins in question, and would form a very cheap source of them in the event of their becoming of commercial value. Consequently, concurrently with these investigations on the nature and properties of apple pectins, attempts have been made to extract in suitable form these substances from pressed pomace. Many methods have been tried, but most of them have given unsatisfactory results, due not so much to any difficulty in extracting the pectins as to the presence of a flavour in the extract which seriously marred its value for the purposes required. Recently, however, a method has been found by which a crude extract of the pectins in concentrated form and free from any marked prejudicial flavour can be readily prepared: and from this a pectin preparation in solid form and not liable to decomposition has been produced.

An American product, stated to consist of apple pectins, has been lately put on the market for use in the jam industry for gelling purposes. The utility of an article of this kind has been admitted. The article in question is in liquid form, and, like other liquid pectin extracts, is apt to ferment readily. A stable pectin in solid form, such as that which has now been obtained from apple pomace, should, therefore, possess distinct commercial possibilities.

PRESSED CIDER APPLE POMACE AND ITS USES.

BY B. T. P. BARKER AND C. T. GIMMINGHAM.

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Under existing conditions it is of national importance that the maximum use should be made of all agricultural produce. While it is probably that good value is already being obtained from ordinary crops and stock, more attention, perhaps, could be profitably given to the by-products of the farm. Some of these may be only of purely local interest on account of their restricted occurrence; but others of more general distribution deserve special consideration. The subject of this article, cider apple pomace, although it does not occur in all parts of the country, is produced in a fairly wide area. It is a product of most farms in Devon, Somerset, Gloucester and Hereford, and to a less degree in Monmouth and Worcester, and also in some districts of the counties adjacent to these. Outside the West of England it is produced in appreciable quantities in parts of Norfolk and Kent, and in small quantities in a few other counties. It is found, in addition, in some localities in Ireland.

Meaning of the term "Pomace."—The term pomace (in some districts it is called "must" or "mark") is used in the cider-making industry to denote the apple pulp in the form in which it is obtained after the fruit has been passed through the cider mill. Sometimes it is further limited to the pulp in the condition in which it comes from the cider press after the juice has been extracted. The material to which attention is here primarily given is the pulp in the latter state. Although the name pomace is used more particularly with reference to the pulp of cider apples it is also applied to the corresponding state of perry pears, and in this article the term is applied without distinction to the product of both apples and pears.

Quantity of Apple and Pear Pomace Produced.—The total quantity of apple and pear pomace produced annually in this country is considerable, and is certainly large enough to make the study of methods for its use worth while. No reliable direct statistics as to the amount are available, but it is possible to gain a rough idea

by indirect calculation from the estimated annual production of cider and perry. According to the Report by the Board of Agriculture and Fisheries on the *Agricultural Output of Great Britain*, the estimated total production of cider and perry in 1908 in this country was approximately 22,133,000 gal. Reckoning at the rate of 125–150 gal. of *mature* cider from 1 ton of fruit,* a standard which experience has shown to be fairly representative of the capacity of the various types of cider presses used in this country, this figure is equivalent to an approximate crop of 147,500–177,000 tons of cider apples and perry pears, and a yield of 44,250–53,100 tons of pressed pomace. The weight of pressed pomace from a ton of fruit varies somewhat. It is here taken as 30 per cent., a fair average figure.

There are various reasons for regarding this estimate as a low one. The year's output, if intended to refer to the cider and perry made during the winter 1907–8, was much below the normal owing to the poor crop of fruit. The late Mr. C. W. Radcliffe Cooke, one of the best authorities of recent years on cider, held that the quantity of cider produced annually reached a much greater figure than that already quoted, and concluded (in an article in the *Nineteenth Century* for 1901) that the total production was not less than 100,000,000 gal. a year. This is probably equivalent to a crop of 666,667–800,000 tons, or a yield of 200,000–240,000 tons of pressed pomace. Mr. John Ettle, late Horticultural Instructor for Somerset, from an intimate knowledge of the cider orchards in that county, reckoned in his evidence before the Departmental Committee on the Fruit Industry of Great Britain, 1904–1905, that the average orchard gave a yield of 275 gal. (5 hogsheads) per acre. The total acreage under cider and perry fruit probably being approximately 100,000 acres, this estimate corresponds to a total annual yield of 27,500,000 gal., *i.e.*, 183,333–220,000 tons of fruit, or 55,000–66,000 tons of pressed pomace.

The only actual figures of the yield of a typical English cider orchard which we have available are those from the old orchard at the National Fruit and Cider Institute. This orchard, well over 80 years old, and fast dying out, yielded crops in 1907, 1908, 1909, 1910 and 1911 at the rate of $\frac{1}{4}$ ton, 1 ton, $1\frac{2}{3}$ ton, 1 ton and $\frac{2}{3}$ ton per acre, respectively, without taking into account a small quantity of dessert and cooking apples which were not used for cider making. This orchard was 5 acres in extent, at least half of the ground was bare of trees, and the great majority of the trees were worn out and unproductive. It may also be mentioned as an established fact that yields of from $\frac{1}{2}$ to 1 ton of fruit from single

* In the case of *apples* used on farms for cider-making the Board's estimate was 175 gallons from 1 ton of fruit.

trees are by no means uncommon in some cider and perry orchards. On the strength of these figures, and at the same time making allowance for the fact that many old orchards are in very similar condition to that mentioned, it seems probable to us that in an average year the total crop of cider fruit is not less than 200,000–250,000 tons, representing a yield of 60,000–75,000 tons of pomace. In any case it is evident that the total quantity available each season is sufficiently substantial to justify consideration of methods for its use.

Composition of Pomace. –The main constituents of the pressed pomace are carbohydrates, principally dextrose and lævulose, with starch and pectins which vary in quantity according to the state of ripeness of the fruit at the time of milling. In addition, smaller quantities of woody fibre and of nitrogenous bodies and fats also occur. The percentage of water is considerable, and ranges from 60 to 80 per cent. of the total weight. Since the composition is practically the same as that of the fruit, minus the juice expressed, it follows that it will depend very largely upon the amount of juice extracted during the pressing. This is a very variable factor. It is affected by the efficiency of the mill and press employed, and also by the length of time to which the pulp is subjected to pressure. Further, the pomace is sometimes broken up again and pressed a second time; and in some districts a certain proportion of water is added, either before the first or second pressing, in order to aid the extraction of the juice. The percentage of residual soluble solids in the pressed pomace is in such cases somewhat reduced. The condition of ripeness of the fruit at the time of milling also affects the quantity of juice extracted, a larger quantity being obtained from ripe fruit than from fruit not quite ripe, or, especially, over-ripe. Individual varieties of apples and pears vary greatly in composition, while the kind of soil upon which the fruit was grown, the age of tree, and the character of the season, also have much influence upon composition.

The table on the following page gives some figures showing the amount of nutrients in some typical samples of fresh pomace. Most of the analyses were made at the Bristol University Research Station. The authorities for the remainder are named. Corresponding figures for mangolds and wet brewers' grains are given for comparison.

It will at once be seen that the apple pomace is very variable in composition, though probably not more so than other fresh vegetable foods. Speaking generally, it is of distinctly higher feeding value than mangolds. It falls below wet brewers' grains as regards the amount of protein, but is richer in carbohydrates.

UTILISATION OF POMACE.

The chief difficulty to be faced in attempts to use pressed pomace is the rapidity with which decomposition sets in. The two principal

Composition of Pomace.

		Mixed Apples. (Wolff).	Mixed Apples. (Warcollier).	Mixed Apples. (Lloyd).	Mixed Apples. 1913.	Mixed Apples. 1915.	"Bell" Apple. 1915.	"Ponsford" Apple. 1915.	"Cap of Liberty" Apple. 1915.	Pear. 1915.	Wet Brewers' Grains.	Mangolds (medium).
Water	..	74.3	78.15	72.4	74.0	76.05	68.39	75.39	75.37	65.52	76.2	88.0
Fat, etc. (Ether extract) ..	..	1.3	0.82	1.08	1.24	1.12	1.43	1.22	(1.20)	1.30	1.7	0.1
Protein	..	1.4	1.5	1.27	1.82	1.53	1.03	1.54	1.33	1.50	5.1	1.2
Crude Fibre	..	10.5	7.15	4.64	5.14	4.42	6.52	5.75	4.30	7.86	5.1	0.9
Ash	..	1.3	0.92	2.27	1.11	0.71	0.65	0.56	0.76	0.92	1.2	1.1
Carbohydrates (Sugar, etc.) ..	..	11.2	9.5	18.34	16.69	16.17	21.98	15.54	17.04	22.90	10.6	8.7

changes which take place in the early stages are alcoholic fermentation and the production of acetic acid. These changes are brought about by what is called locally the "heating" of the pomace, a considerable rise in temperature taking place, and a great part of the sugar being converted into alcohol and acetic acid. The rate of these actions depends upon the prevailing temperature. Further changes leading to putrefaction occur if the pomace remains moist. It is, therefore, important that in all attempts to make use of this material it should be dealt with as soon as possible after it comes from the cider press. If it cannot receive immediate attention it should be stored in the coolest available place and be kept as dry as possible. The question of preservation is considered in a later section.

Pressed pomace has long been used on farms in the cider-making districts as a food for stock. Hogg and Graves Bull in the *Herefordshire Pomona* (1876-1885) mention also its use as a manure, and sometimes, on small holdings, as fuel when dry.

Cider makers in some instances employ the pomace for making a weak form of cider, "small" cider or "washings" (the French "petit cidre"), by adding a limited quantity of water and re-pressing. Another somewhat similar method, which has been investigated in some detail at the National Fruit and Cider Institute, consists in using it to improve low-grade ciders or those affected with acetification and other taints. These methods are considered below.

There are other possibilities which deserve consideration, such as using the pomace for vinegar production or for making cider and perry brandy; but they are somewhat complicated for farm purposes and will, therefore, not be further dealt with here.

There is also some prospect that profitable use could be made of the pectin content of pomace for industrial purposes. A product called "Apple Pectin" has recently been introduced into this country, and it is claimed that it will cause jams to set which will not readily do so themselves. Enquiries have shown that an article of this kind might prove very useful in the jam-making industry; and investigations are now in progress to ascertain if a suitable preparation could be obtained from cider pomace.

Pomace as a Feeding Stuff.—There are very few figures available for the proportion of the principal nutrients which are actually digestible. Warcollier, in his book *Pomologie et Cidricerie*, quoting from Wolff's tables, gives for apple pomace a content of *digestible nutrients* of about 1 per cent. of protein, 1.2 per cent. of fat, and 12.5 per cent. of carbohydrates. The nutritive ratio *i.e.*, the relative proportion of digestible proteins to carbohydrates and fats is about 1:16; and in these days of high-priced feeding stuffs, a waste material of this composition should on no account be neglected.

Most stock will eat apple pomace readily with enjoyment. In

individual cases, cows will not take to it at once, but they can easily be got to like it by introducing small quantities at a time into their ordinary ration. There are, however, certain precautions to be observed in feeding this material. In the first place, unless it has been properly preserved (a matter dealt with in the following section) it must be consumed *fresh*. As mentioned above, if left about exposed to the air the pomace undergoes a rapid acid fermentation in addition to putrefaction, and in warm weather it will be rendered unfit for food in two or three days. Secondly, very much better results will be obtained by feeding pomace mixed with more concentrated foods than by feeding it as a complete ration in itself, as is frequently done in this country. It should not form more than about one-third of the total ration.

In some districts a prejudice exists against feeding apple pomace, and it is true that if fed in too great quantities, especially when not quite fresh, some harm may result. In the case of cows, there is risk under such conditions that the milk may be tainted, and it has been reported that the consumption of very large amounts tends to cause abortion, though this has never been verified. There is, however, no risk of danger to stock if the pomace is used fresh and with reasonable moderation.

Preservation of Pomace.—The rapid deterioration of apple pomace and the necessity of feeding it whilst it is still fresh and sweet undoubtedly prevent an increase in its use as a feeding stuff. On farms and in small factories, where cider is made, the apples are all pressed during a short season in the autumn and early winter, and often more pomace is produced during this period than the stock can eat with advantage. Further, since in the cider-making districts nearly every farm has its orchard and press, little pomace can be disposed of in the locality, and it is not possible to send it any distance. Hence, any means for its preservation are of considerable importance.

Attention may, therefore, be drawn to the fact that pomace can be kept sweet and wholesome for a long time by converting it into a kind of silage. This plan is adopted to a considerable extent in the cider-producing districts of Normandy, but only in comparatively few places in this country.

The simplest method of making such apple silage is to pack the pomace in as fresh a condition as possible into some kind of silo. The silo may be improvised by using tubs or vats, or it may be specially constructed of masonry, or, where the soil is suitable, it may be dug out in the earth, the bottom and sides being covered with layers of straw. The pomace is pressed down very tightly in the silo—the more pressure the better—so as to include as little air as possible, and finally covered with straw and weighted in any convenient manner.

Another plan is to assist the preservation by the addition of from 5–10 per cent. of salt, giving a good sprinkling between each layer of pomace of about 1 ft. thick. By using considerable pressure, and thus keeping out the air, the whole mass becomes thoroughly consolidated, and only a very slow alcoholic fermentation takes place which does not interfere with the palatability or value of the silage. Pomace preserved in this way keeps well for a good many months and is of great value in case of scarcity of keep in the early spring.

Dried Pomace.—When dried, apple pomace is a comparatively concentrated food-stuff of much value. The process of drying cannot, however, be successfully undertaken on a small scale, and it is only in a few of the larger cider factories in this country that drying plants have recently been installed. The product is, according to report, sold to feeding-stuff manufacturers, and is employed in making compound cakes or poultry foods.

Pomace as Manure.—When for any reason apple pomace cannot be used for food it may, if properly dealt with, be turned into a very good manure. Much attention has been paid to this part of the subject in France, and a well-made compost containing pomace as its basis is looked upon as very valuable.

Ordinary samples of pomace contain from 0.2–0.6 per cent. of potash, 0.4–0.7 per cent. of phosphoric acid, and 1.6–1.7 per cent. of nitrogen, so that it is richer in manurial constituents than farm-yard manure. The continually increasing acidity is an objection to its direct application to the land, and in order to neutralise this it is usual to add chalk, marl or lime. This is well mixed with the pomace and some soil, and the heap is then allowed to stand for some time with occasional turning until it is well rotted down. A good mixture would seem to be 4 parts of soil, 4 parts of pomace, and 2 parts of lime.

A more ingenious device, which is frequently adopted in France, is to mix the pomace with a quantity of bone or mineral phosphates. The acid produced during fermentation is said to bring much of the insoluble phosphate present into a more readily available form, thus increasing the manurial value of both the phosphate and the pomace. In order to test this plan under English conditions, some experiments have already been started.

POMACE FOR MAKING "SMALL" CIDER OR FOR IMPROVING THE QUALITY OF LOW-GRADE CIDER.

"Small" cider is made by pouring water on the pressed pomace, which has previously been broken up roughly, and allowing the moistened pulp to stand for a few hours, preferably overnight, in a wooden vessel before re-pressing. The expressed liquor is practi-

cally a diluted form of the residual juice in the pomace, and is treated in essentially the same way as pure juice for cider-making. Its quality obviously depends upon the proportion of water added to the pomace, and this should be determined by the purpose for which it is intended to use the small cider. In practice it is generally found that if water is added at the rate of 1 gal. to every 10lb. of pomace the resulting juice possesses a specific gravity of 1010-1015. This is equivalent to a gain of 3-4 per cent. of sugar. The addition of a smaller proportion of water produces a juice of correspondingly higher specific gravity and richness in sugar. In making small cider it is well to endeavour to obtain a specific gravity of 1030 in the freshly-expressed liquor. This may be done either by reducing the proportion of added water, by expressing less of the pure juice from the pomace to be treated in the original, or by the addition of sugar. Small cider properly made is a pleasant light beverage, especially suitable for summer use on the farm.

A similar course of procedure is adopted for the improvement of inferior or tainted cider, the latter being used instead of the water for adding to the pomace as in making small cider. On most farms there is generally cider to be found which will benefit by this treatment, whether it be early-made cider from "windfalls," or acetified or otherwise tainted cider from a previous season's make. The manner in which taints in flavour are more or less completely removed by this process of "re-soaking" is very marked; and it seems probable that there is something more than a mere admixture of old cider and new juice taking place.

NEW TRIAL CIDER AND PERRY ORCHARDS, 1915-16.

BY B. T. P. BARKER.

The usual annual reports on the trial cider and perry orchards which have been established with trees supplied by the Institute, are this year omitted. In many of these orchards the trees are now coming into bearing, and samples of the fruit are in such cases being analysed at the Institute. When sufficient results have been obtained, it is proposed to publish them.

There have been few fresh developments during 1915 in the direction of planting new orchards on account partly of labour difficulties and partly of the expense of planting at the present time. Five hundred and forty trees were sent out for establishing new orchards, and for completing orchards already established. Particulars of these are given in the table on the following page. In addition 61 trees were supplied for filling gaps in existing orchards, and 95 sold to Members and Associates of the Institute.

NEW EXPERIMENTAL ORCHARDS PLANTED IN 1915-16.

VARIETIES SELECTED.

CENTRE.	APPLES.			PEARS.
	SHARP.	SWEET.	BITTERSWEET.	
<i>Gloucester County Trees.</i> Arlingham	Red Manse (5)		Silver Cup (10) White Bache (9)	
<i>Brookthorpe Court,</i> nr. Gloucester ..	Lambrook Pippin (10) Dymock Red (10)	Sweet Alford (10) Woodbine (10) Doux Amer (5) Pole Carew (10)	Knotted Kernel (10) Osborn's Cadbury (10) Royal Jersey (10) Yarlinton Mill (20)	Oldfield (20) Barland (10) J. Amphlett (10) Moorcroft (10) Taynton Squash (5)
<i>Hereford County Trees.</i> Court Farm, Aylton ..	Cap of Liberty (9) Dymock Red (10) Foxwhelp (10) Kingston Black (10) Skymo's Kernel (9) Gilder Pearmain (10)	Sweet Alford (9) Eggleton Skyre (20) Ashton Brown Jersey (10)	Knotted Kernel (10) Strawberry Norman (5) Long Stem (7)	Royal Wilding (10) Harry Masters' Jersey (10) Major (10)

<i>Monmouth County Trees.</i>		
Bassaleg, nr. Newport ..	Sweet Alford (21) Woodbine (9) Sweet Coppin (14)	White Close Pippin (10)
Rhiwderin, Newport ..	Cap of Liberty (19)	Rouge Bruyère (3)
<i>Somerset County Trees.</i>		
South Barrow, Sparkford ..	Cherry Pearmain (10) Cowarne Red (5) Gatecombe (5)	Roussie (5) Brown Snout (10) Knotted Kernel (5)
<i>Worcester County Trees.</i>		
Chaceley Hall, nr. Tewkesbury ..	Langworthy (5)	Brown Snout (10)
Blakemore, Rock, Bewdley ..	Lambrook Pippin (10) Foxwhelp (5)	White Close Pippin (15) Médaille d'Or (10)

FURTHER SPRAYING EXPERIMENTS ON THE SUMMER STAGE OF AMERICAN GOOSEBERRY MILDEW.

BY B. T. P. BARKER AND A. H. LEES.

In the Report for 1914 an account was given of various spray fluids tried against American Gooseberry Mildew. The underlying principle of treatment there emphasized was that "if the development and spread of the summer stage could be held in check sufficiently, the occurrence of the winter stage would be so much reduced that outbreaks the following season would be relatively few."

The procedure adopted in the 1914 experiments on affected bushes was to apply, firstly, a spray which would kill by direct contact as much as possible of the *conidia* and mycelium present on the bush, and, secondly, a protective spray to keep the parts on which the fungus had thus been killed free from infection from external sources. A number of fluids of the first type, i.e., "hitting" or "contact" sprays, were tested, including one composed of 4lbs. of liver-of-sulphur and 20lbs. of soft soap in 100 gallons of water. On each of the plots thus treated a series of protective or "cover" sprays such as Bordeaux mixture, lime-sulphur, etc., were applied. The applications were made at the end of July, the outbreak being a very late one. None of the results were entirely satisfactory, the mildew reappearing fairly generally, although only slightly.

In the course of this experiment it became evident that the "hitting" sprays were all more or less ineffective because they failed to wet the fungus uniformly owing to the presence of air between the *conidiophores* and the *conidia*. The importance of this point has also been emphasized in a recent paper by Dr. Eyre and Mr. Salmon.* Because of this difficulty they used their test fluids made up with 1 per cent. soft soap. We, however, found in our experiments that twice that quantity of soft soap did not suffice to give complete wetting, when the fluids were tested on a practical scale.

The failure of soft soap alone to give the spray fluids under trial the necessary degree of wetting power led eventually to the use of

* "Journal of the Board of Agriculture," Vol. XXII., No. 11.

soft soap-paraffin emulsions. From previous spraying trials against Woolly Aphis on apple trees it had been found that with the comparatively hard water at Long Ashton the most wetting combination was an emulsion of paraffin in soft soap solution at the rate of 20lbs. of soft soap and 2 gallons of paraffin to 100 gallons of water. With soft water not more than 15lbs. of soap need be used. This emulsion, both when used alone and when various fungicidal substances were dissolved in it, proved capable of wetting completely the densest patches of mildew. Even when a fungicide was not added to it, it appeared to possess a marked toxic action on the mildew, the *conidia*, so far as could be judged in the original trials by a microscopical examination, being killed after contact with it. The results of subsequent experiments tended to show that the emulsion alone could not be relied on to kill completely the "summer stage": and on that account it was eventually decided after trial to use it in conjunction with liver-of-sulphur for the 1915 experiments.

It was intended to continue these at the Institute during the summer of 1915, but owing to the late and desultory appearance of the disease no satisfactory experiment could be made. Arrangements had, however, been made to treat a small plantation in the neighbourhood of Weston-super-Mare on commercial lines. This plantation in the previous year had been severely attacked and offered every chance of an early and severe attack in 1915.

In order to obtain the conditions required for successful treatment on an experimental commercial scale two points must be attended to. Firstly, an efficient fungicide must be used, and, secondly, reinfection from outside sources must be prevented. The second condition was fulfilled as far as possible by working on a comparatively isolated plantation. It is difficult to find a severe case of American gooseberry mildew on a completely isolated plantation which is at the same time of moderately easy access, but the one referred to above fulfilled these conditions as nearly as possible.

The plantation treated consisted of bushes of Whinham's Industry and Keepsake, and was situated a hundred yards or more from the next plantation of gooseberries, in which the disease also occurred. The outbreak appeared in May and by the beginning of June the berries and young shoots of the Whinham's and the young shoots of the Keepsake bushes were freely attacked. The fruit of the former variety was largely covered with the summer stage, and remained ungathered on the bushes throughout the course of the experiment. When the disease appeared to be at its height, about the middle of June, the spray was applied. The fungicide used was the soft soap-paraffin emulsion referred to in the previous paragraph to which was added liver-of-sulphur at the rate of $3\frac{1}{2}$ lbs. per 100 gallons of the fluid, *i.e.*, a 2 per cent. emulsion containing

approximately .35 per cent. of liver-of-sulphur. It may be made as follows:—In 5 gallons of boiling water 20lbs. of soft soap and 3½ lbs. of liver-of-sulphur are dissolved by constant stirring. In this hot liquid 2 gallons of paraffin are emulsified. For use add 19 gallons of water to every gallon of concentrated emulsion. The best brand of paraffin to use is that known as "Solar Distillate." It is somewhat heavier than the ordinary lighting quality, and, according to Pickering, is less liable to scorch foliage. It has also the advantage that, being heavier, and thus of a higher flash point, it is more readily taken by the railway companies. At the same time its use is not essential and ordinary lighting paraffin may be substituted with a reasonable amount of safety.

Two points must be attended to in order to obtain a successful paraffin emulsion. Firstly, the soap solution should, if possible, be hot, and, secondly, the paraffin should be syringed with violence into the soap solution and not simply stirred into or shaken up with it. The most convenient instrument to use for emulsification is an ordinary garden syringe with a rose attached.

This fluid, from the preliminary trials, appeared capable of completely wetting and killing the mildew, when applied with reasonable care, and at the same time caused no scorching or defoliation and no disfigurement of the foliage or fruit. It was therefore chosen for the Weston trials. An examination of the diseased shoots and berries a few days after spraying showed that the production of new *conidia* had ceased and that apparently the fungus originally present had been killed completely. It had originally been intended to spray the bushes again at intervals during the remainder of the summer; but except for a very slight new outbreak on a few of the shoots of the outermost bushes of the "Whinham's" plot no further growth of the mildew occurred. It was therefore considered unnecessary to make any further spraying. There was no damage done by the spray fluid to the bushes except in the case of a few Keepsake plants which received the last portion of the fluid. In this instance some scorching appeared, and was caused evidently by a too great concentration of emulsion owing to lack of agitation in the knapsack machines used. On the few shoots which eventually showed the living "summer stage" the "winter stage" in due course appeared. Very few *perithecia* were formed, and in none of those examined were ripe spores observed. The critical test of the experiment is, of course, the re-appearance of the disease and the time of the outbreak in 1916. As to this nothing can yet be said: but the experiment last year certainly serves to show that the liver-of-sulphur-soft soap-paraffin emulsion is capable of drastically reducing the amount of the summer stage in an affected plantation and, provided that the spraying is administered as may be necessary, also of corres-

pondingly curtailing the production of the "winter stage." Further than this conclusion it would be at present unwise to go.

It is probable that the character of the weather last season and the heavy crop of berries carried by the bushes prevented the formation of the succulent young growths by the bushes which are mainly the object of attack and that, accordingly, the spread of the disease from the few shoots which bore living *conidia* after the spraying was hindered. On this account no satisfactory conclusion can yet be drawn as to the number of sprayings required to keep the "summer stage" under control. Trials in a plantation of young, vigorously growing bushes are required for this purpose.

The cost of the mixture at pre-war price per 100 gallons works out as follows:—

		<i>s.</i>	<i>d.</i>
Soft Soap, 20lbs. at 14s. per cwt.	...	2	6
Paraffin (Solar Distillate), 2 gallons at 7d.	...	1	2
Liver-of-Sulphur, 3½lbs. at 8d.	...	2	4
Total	...	6	0

It should be remembered, however, that owing to its good wetting power less solution is used per bush than would otherwise be the case. With soft water 15lbs. per 100 gallons would be amply sufficient, thus reducing the price to 5s. 4d. per 100 gallons.

It is important to note, too, that the mixture is an efficient aphicide. Owing to its penetrative power and good wetting action it does much to check attacks of gooseberry aphid which frequently cause serious dwarfing of the summer growths. This aphid is a serious pest not only owing to the actual damage it does to the bush, but also in its indirect action on mildew. Owing to its presence the terminal leaves are much curled and folded, and it is in these obscure hiding places that the mildew remains untouched by ordinary fluids and only with difficulty reached by an emulsion. Some of the cost of the materials may therefore be quite fairly placed against the aphicidal value of the fluid.

As to the composition of the mixture itself, it is believed that, where the treatment of the "summer stage" of mildews by a "hitting" fluid is concerned, the employment of a wetting fluid of the paraffin emulsion type is essential; and, so far as trials to date go, none approach the 2 per cent. soft soap-paraffin emulsion for effectiveness and cheapness combined. The choice of an active fungicide to supplement the toxic properties of this emulsion is still an open question, as indeed is the need for the inclusion of such a substance. Liver-of-sulphur was selected, to some degree arbitrarily, for the experiments which

have been described, and appears to have acted very successfully : but further work may well show that there are better fungicides for the purpose.

In this connection the results of the experiments of Messrs. Eyre and Salmon recorded in their paper referred to above, are of particular interest. They found that liver-of-sulphur failed to give satisfactory results, even when 1 per cent. soft soap solutions were used to increase the wetting properties of the spray. This mixture appears to have given complete wetting in their experiments : but in our own even 2 per cent. soft soap solutions failed to wet thoroughly the denser patches of mildew. The conclusion to be drawn from both their and our experiments is, however, the same, viz., that liver-of-sulphur used either in water alone or in soft soap solutions is inefficient for controlling the mildew. As already seen in the experiments above described, liver-of-sulphur in mixture with soft soap-paraffin emulsion instead of with water alone or soft soap solutions seems to be highly efficient. Whether or not this is due simply to the better wetting power of the emulsion or to the combined toxic action of the paraffin and liver-of-sulphur remains to be proved. In their series of experiments Messrs. Eyre and Salmon did not use this mixture ; but they propose to do so this season, and it will be interesting to see if liver-of-sulphur when used in this combination still fails to act adequately under the conditions prevailing in Kent.

They have tested with promising results a new substance, ammonium sulphide : and it is proposed in our experiments this season to compare the effect of this, both in ordinary aqueous solutions and in soft soap-paraffin emulsion, and of the liver-of-sulphur soft soap-paraffin emulsions.

FURTHER EXPERIMENTS ON BIG BUD MITE.

By A. H. LEES.

In March, 1914, as noted in the Report for 1914, the following sprays were applied to black currant bushes badly attacked by the mite :—

- | | | | | |
|----|-----|-----------|------|-----------------------------|
| 1. | 10% | Soap Soft | | |
| 2. | 10% | „ | +10% | Paraffin Emulsion. |
| 3. | 4% | „ | +10% | „ in Unstable Emulsion. |
| 4. | 6% | „ | +20% | „ „ „ |
| 5. | 10% | „ | + 2% | Oil of Mirbane in Emulsion. |

The results from these trials were disappointing. Nearly all the bushes showed an increase of big buds in the autumn of 1915. The only exception was in the case of two or three bushes that had been sprayed with 10% soft soap in December. These showed a very marked diminution in the number of affected buds.

For some unexplained reason penetration was more than usually effective, and at the time practically no eggs were present in the buds. In the case of the March sprayings there were a great number of eggs present that were probably unaffected, thus producing mites for the migratory period even when the adults had been killed.

From these results it became evident that it was desirable, if possible, to apply a mite-killing wash before January, the month in which eggs first begin to appear in numbers.

Since 10% soft soap cannot be trusted to give complete penetration an endeavour was made to find some substance or substances which, given a small quantity introduced into the bud, would kill by vapour treatment. A number of these, including paraffin, carbon disulphide, oil of mirbane, and ammonia, were tried on a small scale in the laboratory, but no satisfactory results could be obtained. Most of these substances produced a temporary anaesthesia but the effect was not lasting enough to secure killing. This line of experiments were therefore given up.

There still remained, however, another possible way of dealing with the mite by spraying methods. If it were possible to introduce some substance, together with the soft soap, that would kill the entire big bud, the problem would be solved, since the mites feed on the tissues of the bud, and cannot stand desiccation.

It should be noted in this connection that 10% soft soap has practically no penetrative power into normal buds. In the table below is a list of the substances tried with the object of killing the big bud itself. In all cases they were combined with 10% soft soap to obtain penetration.

SUBSTANCE.		RESULT.	
Caustic Soda	2% ..	..	After five days most mites killed. Bud moderately blackened, but not enough.
" "	2½% ..	..	Buds partially killed.
" "	3% ..	" "	" "
Potassium dichromate	½% ..	..	After two weeks failed to kill bud.
" "	1% ..	" "	" "
Sodium arsenate	½% ..	" "	" "
" "	1% ..	" "	" "
Crude Carbolic Acid	2% ..	..	After three days normal buds healthy. Big buds looking as if they would die.
" "	5% ..	..	Killed big buds well, leaving normal buds unaffected.
" "	10% ..	..	Killed normal and big buds.

Here by far the best result was obtained by 5% crude carbolic acid.

Outside the following formulæ were used :—

10% Soft Soap	+1%	liver-of-sulphur.
" "	+2%	crude carbolic acid.
" "	+4%	" " "
" "	+5%	" " "
" "	+2%	" creosote. "
2% Paraffin		
Emulsion	+4%	" carbolic acid.

The results are not to hand at the time of writing.

THE APPLICATION OF SPRAY FLUIDS TO TREES IN THE DORMANT CONDITION.

By A. H. LEES.

Winter spraying is conducted either with a view to cleansing the tree from lichen and mossy growths, or with the idea of putting the eggs of certain insect pests out of action.

The first purpose may be easily secured by spraying with 2% caustic soda or with lime wash. The second purpose may also be secured by lime washing trees just as the buds are bursting. Just how late this may be done is uncertain, but the point is under investigation at present. The trees cannot, however, then be said to be in the dormant condition. Proprietary spray fluids have appeared for which claims have been made that they kill all fungus spores and insect eggs which they touch. These "cure all" claims might well make a grower suspicious, and, indeed, on being put to the test these fluids have failed miserably. Recently the advertisements supporting the claims of such spray fluids have become much more moderate in tone. No spray fluid has, as far as the author knows, yet been proved to be ovicidal. This is not surprising as the problem of killing insect eggs on fruit trees is by no means simple.

The shell of insect eggs consists of a substance called "chitin" which is of a horny nature. It is extremely resistant to chemical action, though there is evidence that it is slowly attacked in the soil by bacteria. Were this not so masses of chitin from dead insects would collect in the soil as undecomposable products. The subject is made more difficult in that with these washes the fluid only remains in contact with the eggs for quite a short time, since under ordinary conditions, drying takes place rapidly. At the same time the advantages of a winter ovicidal wash would be so great that it was thought worth while experimenting in that direction.

HOT WATER.

One of the most hopeful methods at first sight was the use of plain hot water. It was necessary to determine first of all at what tem-

perature eggs could be killed. In order to do this twigs with eggs of aphids, apple sucker, and red spider were dipped for one second into water of various temperatures.

It was found that not until a temperature of 70°C. (158°F.) was reached was there any sign that the eggs were killed. At this temperature some of the eggs showed on examination that their contents had become thickened. At 90°C. (194°F.) all the eggs were obviously killed. Of course it is possible that a lower temperature than 70°C. would be sufficient, but owing to the impossibility of incubating eggs in an early stage of development in the laboratory a temperature of 70°C., was considered to be the minimum for hot water spraying.

When hot water is sprayed through a nozzle there is known to be a considerable reduction of temperature before the liquid hits the tree. M. Semichon* in using hot water in treatment of vines in active growth, found that with water at 102°F., in the tank and using a vermorel sprayer with a hand pump and a coarse nozzle, the temperature was reduced by increasing the distance from 4 to 20 inches from 158°F. to 139°F. With a fine nozzle it was reduced from 153°F. to 131°F., and with a pressure sprayer from 122°F. to 101°F. †M. Chanvigné found that with a tank temperature of 160°F. and with the use of a fine jet the temperature dropped to 151°F. at 4 inches, to 132° at 8 inches, to 118° at 12 inches, to 110° at 16 inches, and 103° at 20 inches. Even when the contents of the tank was heated to 212°F. only 117°F. was registered at 20 inches away. The present author found that using a knapsack machine with a coarse nozzle and at a distance of about 10 inches the losses were as follows:—

Temperature of Water in Tank.				Issuing Water.	
185°F.	...	...	...	...	131°F.
149°F.	...	...	...	...	112°F.
132°F.	...	...	...	...	104°F.
117°F.	...	...	...	...	94°F.

These results all go to show that it is almost impossible to obtain a temperature of 158°F. under ordinary spraying conditions, and the hot water method was given up as useless for winter treatment of eggs.

* Rev. Vitic. Paris, Vol. xliii, No. 1118, 2nd December, 1915.

† Loc. i.d.

THIN SPRAY FLUIDS.

Certain further thin spray fluids were tried with the results given as under :—

SUBSTANCE.				RESULT.			
$\frac{1}{2}\%$	Soap +	5%	Nitrobenzene	..	..	Killed eggs and buds.	
$\frac{1}{2}\%$	"	+10%	" "	..	..		
1%	"	+4%	" "	..	..	Buds " uninjured." Some eggs	
						apparently killed.	
$\frac{1}{2}\%$	"	+2%	" "	+2%	Paraffin	..	Buds living. Eggs doubtful.
1%	"	+20%	Sodium Carbonate		..	"	" " living.
1%	"	+10%	Sodium sulphate		..	"	" " "

None of these proved successful, and their use was therefore given up.

BLEACHING POWDER MIXTURES.

Sodium hypochlorite solutions are used as laboratory reagents for preparing chitinous objects for examination, and it was thought possible that the method might be adapted for spraying work. Owing to the expense and other considerations it was impossible to use the same strength of solutions as are used for laboratory purposes. A considerable number of different formulæ were tried, some giving fairly successful results. Most of them were mixtures of bleaching powder solutions and alkalis. The method gives promise of success, but it has not yet been fully worked out. It has been found necessary to combine solution with an ordinary lime mixture in order to keep the liquid in contact with the eggs for half an hour or more.

Under such conditions using the mixture as an ordinary spray fluid it has been found possible to kill apple sucker eggs and probably also aphid eggs. The work will be continued in the direction of obtaining as cheap a mixture as possible, but the results are not yet sufficient to give any details.

THE WINTER TREATMENT OF MUSSEL SCALE.

BY A. H. LEES.

The mussel scale, *Lepidosaphes ulmi*, is a common pest of the apple. It attacks many different trees, but apple is the usual host. It is difficult to calculate exactly how much damage it does. It has, however, clearly two injurious effects. First, it must cause considerable loss of sap to the tree. If a piece of scale covered bark be sliced tangentially so as to expose the cortical tissues, a great number of small circular brown marks are seen. The centre of each mark indicates the place where the sucking mouth parts of the insect have penetrated. From their great number it is clear that from a badly attacked tree a considerable quantity of liquid must be taken. It is difficult to say exactly where the sucking apparatus terminates. On the trunks of fair-sized standards it does not appear to reach the wood, and in these cases liquid is probably absorbed from the cortex and phloëm. If the phloëm is, indeed, attacked, and from the insect's point of view this tissue would undoubtedly provide the most nourishment, it can easily be seen that great damage might be done. The stream of elaborated food products going to the root would be greatly checked, and the roots starved in consequence.

The second clear source of damage is the injury to the bark. After some years it becomes rough and scurfy, and is obviously in an unhealthy condition. As a result the tree becomes bark bound. This condition is partially explained when the sliced-off piece of bark, above alluded to, is examined.

The injury due to the insertion of the insect's mouth-parts is not confined to the cells immediately surrounding them, but spreads for some little distance around.

As a result, on a heavily attacked tree there is very little of the cortical tissues that remain uninjured. Bark formation is greatly interfered with, and instead of growing with the increasing size of the tree, it remains stationary, or almost so, until the expanding force is great enough to crack it.

The damage is, therefore, serious enough to warrant immediate treatment by the fruit grower.

In Professor Theobald's book on "Insect Pests and Fruit" an interesting account is given of various spray fluids tried both in summer and winter.

In conclusion, he recommends either a strong soap-paraffin emulsion, or Woburn wash, but deprecates the use of caustic alkali fluids, "as undoubtedly harmful to the trees."

At Long Ashton three winter spray fluids were tried. They were as follows :—

Caustic Soda 2% (2lbs. per 10 gallons).

Paraffin Emulsion (Paraffin 10%, Soft Soap 10%).

Lime Sulphur (1 gallon commercial concentrate to 12 gallons water).

The high proportion of soap used in the paraffin emulsion was to ensure the utmost possible penetration under and into the scale. Laboratory experiments had shown that it possessed considerable penetration power.

The trees were examined in the early summer when it was found that the paraffin emulsion and a lime sulphur had failed to produce any obvious reduction in the amount of scale. The trees sprayed with caustic soda were, on the other hand, completely free from scale. They suffered no injury that could be ascertained. In view, however, of Theobald's experiments, where he reports of this wash that "the trees appeared cleaner, but in no case was any apparent damage done to the scales," it would be unwise to assume that caustic soda is successful under all conditions. It will be given further and more extensive trials at Long Ashton.

FRIT-FLY EXPERIMENTS.

BY A. H. LEES.

The frit-fly has existed in Wiltshire, as far as can be ascertained, at least five years. Some years the damage done is greater than in others, 1914 being a particularly bad year.

The experiments carried out this year were quite of a preliminary nature, and it is hoped that, with further knowledge of the pest, more useful recommendations will be possible.

There is a certain amount of information available in text books as to the life history of the insect, but many important details are not stated. It is often these small details that give a clue to some feasible method of control, so that, undoubtedly, before undertaking extensive experiments it is highly important to obtain as much information as possible in the field. With this end in view, five farms in the county were chosen, at which experiments could be done, if desirable, and where, at any rate, the life history of the insect could be followed. The farms were at Ashton Keynes, Broad Hinton, Aldbourne, Longbridge Deverill, and Dinton. Each place was visited twice during the summer—once in June and once in August—and useful information was obtained.

It would, perhaps, be well to point out here how difficult it is to control agricultural insect pests. Compared with a fruit orchard, the value of the crop is small and the expenses of control must always be limited by the net profits on the crop, except in cases where energetic measures will give immunity for some years. The wide acreage of agricultural crops also greatly increases the difficulty of obtaining labour for operations on a large scale. It is, therefore, necessary in most cases, to rely on suitable cultural operations for controlling agricultural insect pests. The life history of the frit-fly as stated in text books may be summarised thus:—The fly appears in May and lays its eggs on the young oat leaf. The egg hatches and the escaping maggot bores its way into the growing point of the oat. Towards the end of June it enters the puparium stage, that is, it forms a cocoon where it rests till the middle of July. It then emerges as a small fly similar to the one appearing in May. Instead, however, of laying its egg on the leaf, it lays it on, or in the developing grain of, the ear. Here the larva of the second generation

feeds until August, when it changes after a cocoon stage into the fly again. This fly is said to lay its eggs on wild grasses, and the resulting larva there exists through the winter. In the spring, after the third cocoon stage in its life history, it comes out as the perfect fly, which attacks the oat in May.

Such being the accepted life history it was thought that it might be possible to prevent egg laying by a suitable deterrent. Crude naphthalene was the substance used, and sufficient quantities were sent to the five centres. It was applied to the ground in the early part of May, just when the fly should be appearing. The smell of naphthalene is objectionable to most insects, but in this case it exerted no beneficial effect.

Where any quantity of rain occurred within two days, the oats were damaged rather badly. Where, however, it did not occur until a week after application, the damage was hardly perceptible, and, in one case, a considerable stimulating effect on the clover underneath was observed. This was probably due to the partial sterilization of the soil, a subject recently worked out by Dr. Russell, of Rothamstead. This first experiment was, therefore, a failure, but the farms were visited with a view of gaining further information. In addition, forms were sent out by the Secretary from the County Offices requesting certain information, and a considerable number of answers were obtained. Summarising these answers the following points became clear: (1) winter oats are never attacked, (2) early spring oats usually succeed better than late ones, and (3) no variety is immune. These points were brought out also at my visits, and showed that at the five centres winter oats were always immune.

Spring sown oats may be divided into those planted early, in mid-season, and late. These terms are purposely made vague, as what is early for a late farm, may be late for an early farm. Each farmer would have his own date to assign to these terms, depending on the site of his farm and the character of the season.

In nearly every case visited the early sown oats were less affected than the later sown. In one case, however, a late sown piece, planted probably about the beginning of May, escaped, while a piece on the same farm, planted at the beginning of March, was rather badly attacked.

At the time of my second visit to these farms, in August, all the oats under observation, had very much improved. This was probably due to the heavy rains early in July; at the time of their occurrence the second generation of the fly was appearing, and no doubt many flies were thus destroyed. At the same time the oat plant was stimulated in growth. The combined result was that the crop, which in many cases was badly affected, recovered partially, and a better harvest was obtained than was expected.

The damage done by the fly is two-fold. The first generation

attacking the growing point of the oat causes the plant to tiller. These side shoots, if not interfered with, do not ripen enough by harvest time to produce full-sized grains, but only light ones. As a rule, however, the second generation of the fly causes still more damage by attacking the developing grains, which are completely eaten out. The fly, which develops from the grain, which is the third time the pest appears in the fly stage during the year, begins to appear soon after the crop is cut, and before it is carted. Probably most of them come out during the time the oat is in the stack, but flies are known to appear right into the late winter. The methods of control that this life history allows are not many.

Where winter oats can be planted this should be done, and failing that, planting should take place as early as possible. This still leaves cases where neither of these procedures can be carried out. Nothing can be recommended for these cases at present.

MISCELLANEOUS NOTES.

BY A. H. LEES.

LIME WASHING.

Lime washing against apple sucker and aphids of apple and plum is now an established practice. While the mixture may be improved as regards adhesiveness by the addition of certain substances, lime alone may be used with very good results if certain conditions are fulfilled. The important points are :—

- (1) Spray as late as possible. It is still safe when the buds have just started moving.
- (2) The lime should be as fresh as possible.
- (3) It should be white lump lime of 98% purity, and not impure dirty-coloured agricultural lime, which does not give good results for spraying.
- (4) Twenty pounds of lime should be used for every ten gallons of water.
- (5) It should be strained before using through a sieve having 16 meshes to the inch.
- (6) Slake the lime for six hours before using, if possible. Well slaked lime sticks better than lime slaked in the ordinary way. It is a good plan to add one-third the total quantity of water immediately; then allow to slake thoroughly. For use take one pailful of the lime paste to two of water and well mix. This operation makes for economy of tubs and allows more to be made up overnight if much spraying is to be done the following day.
- (7) The more fine particles are obtained during slaking the better the mixture, and the more adhesive.

To obtain the maximum of fine particles :—

- (a) Use fresh lime.
- (b) Always keep the lime covered with water while slaking, but
- (c) Keep the mixture while slaking as hot as possible.

AUTUMN INFESTATION OF APPLE AND PLUM APHIS.

Two of the apple aphides and one plum aphis which lay winter eggs on the trees migrate during summer to another host plant, and return for egg laying to the trees in the autumn.

It is, therefore, worth while examining plums and apples in October and November to see if there are any aphides on the under surface of the leaves. If abundant and eggs are subsequently laid there is a great probability of a spring attack, and lime washing in the spring is advisable. If few or none the probability is that there will be no serious spring attack, and the grower if pressed for labour in the spring might leave the trees unsprayed.

At Long Ashton in the autumn of 1915 there were abundant returned migrants on the apple, followed by many eggs laid, while the plums were practically free.

It is possible that observation in October and November may prove to be a safe guide as to the necessity of spraying in spring. No reliance can, of course, as yet be placed on the method, but these facts may prove of service to growers.

PARAFFIN EMULSIONS.

Paraffin emulsions suitably made form good and cheap contact insecticides, with very good wetting properties. Many different formulæ have been advocated, but in most of them the ratio of soap to paraffin is too low. When this is so they show a great tendency to scorch foliage. As a result of recent work at Long Ashton the following conditions should be observed :—

- (1) Stock emulsion should be made, if possible, with hot soap solution.
- (2) The paraffin should be syringed with force into the soap mixture, using an ordinary garden syringe with a rose attached.
- (3) For every strength of paraffin in the emulsion there is a certain percentage of soap necessary in order to obtain a stable emulsion. For soft water they are as follows :—

Percentage of Paraffin required.				Least percentage of Soap necessary.	
1-5	...	...	...	...	$\frac{1}{2}$
5-10	...	...	...	...	1
10-25	...	...	...	...	$1\frac{1}{2}$

For water of moderate hardness represented by 12° on the ordinary scale of hardness of water :—

1	...	...	...	...	1
2-5	...	...	...	...	$1\frac{1}{2}$
10-25	...	...	...	...	2

Roughly speaking 12° of hardness uses up and nullifies $\frac{3}{4}\%$ of soap.

Therefore for every extra 12° of hardness $\frac{3}{4}\%$ of soap should be added to the above figures.

- (4) Stock solutions should not be kept more than a few days as they slowly undergo de-emulsification.

For ordinary summer use the following formula has proved useful for water of moderate hardness :—

Soft soap, 40lbs.

Paraffin, 4 gallons.

Boiling water, 10 gallons.

Dissolve the soap in the hot water and syringe the paraffin forcibly into the solution. When all the paraffin is added continue the syringing for a short time till a perfect emulsion is formed.

For use against wax-covered insects, such as Woolly Aphis of apples, use 1 part by volume of stock to 19 of water. For use against ordinary aphis, such as plum, apple, cherry aphis, use 1 part by volume of stock to 39 parts of water.

The first formula gives a 2% emulsion, and the second a 1% .

Where possible paraffin of the brand known as Solar Distillate should be used. but where not available ordinary lighting quality may be employed.

A NOTE ON *PHYTOPHTHORA INFESTANS* (DE BARY) OCCURRING ON TOMATOES.

BY S. P. WILTSHIRE.

During August, 1915, the tomatoes under culture at this Station were attacked by a virulent disease, causing the stem to blacken, and finally become soft, the whole plant above being killed. The most usual place of attack was near a spot at which a young shoot had been nipped off, although it occasionally occurred on the petioles and leaflets. In the latter case the lamina becomes brownish and dead, resembling very closely the potato disease, although the number of leaflets attacked is never so large nor the damage so great.

On placing diseased portions of the stem in moist chambers, abundant conidispores were produced bearing numerous conidia. Microscopic examination of the fungus showed no morphological difference between it and the fungus causing "Potato Disease," viz., *Phytophthora infestans* (de Bary). Stevens and Hall in their "Diseases of Economic Plants" give *Phytophthora infestans* as a disease of tomatoes. Engler also gives the tomato as a host of this fungus. In the Report of the Wye Agricultural College for 1913, p. 494, however, G. Smith records some experiments which he has carried out with the object of finding out the various hosts on which *Phytophthora infestans* will grow. He states that the potato fungus will not attack the tomato!

The facts, as reported, therefore showed that, whilst the tomato cannot be directly infected with the *Phytophthora* from the potato, yet a fungus morphologically identical with it is found to occur on this host. This suggested that a physiological differentiation of species of *Phytophthora infestans* might exist, and experiments have been made to test this hypothesis.

SERIES 1.—

Cross inoculations were made with suspension of spores in water on cut shoots placed under bell jars. The positions of the inoculations were marked with Indian ink.

- (a) Spores from Potato on Potato ($\frac{42}{123} =$) 34% approx. successful infections.

- (b) Spores from Potato on Tomato ($\frac{0}{113} =$) 0% approx. successful infections.
- (c) Spores from Tomato on Potato ($\frac{1+3+1}{17} =$) 3% approx. successful infections.
- (d) Spores from Tomato on Tomato ($\frac{43}{116} =$) 37% approx. successful infections.

SERIES 2.—

Inoculations of whole plants by moistening leaves, etc., and rubbing infected portions over the surface. Plants placed in moist atmosphere. This method of inoculating, suggested by Mr. G. T. Spinks, was found to be very effective. The lateness of the season prevented healthy potato plants being available for this experiment.

- (a) Spores from Tomato on Tomato (2 plants), very heavily infected.
- (b) Spores from Potato on Tomato (2 ,,), no infection.

SERIES 3.

In a few experiment spores from the potato were placed on injured portions of the tomato. In one or two cases successful infection occurred, but in many cases it did not.

The conclusion which is suggested by these results is that the *Phytophthora infestans* attacking potatoes is of different physiological strain from that attacking tomatoes, but that it is possible for infection of the tomatoes to be initiated by inoculation of injuries of the latter by the fungus from the potato.

A BLACK ROT OF APPLES.

BY G. T. SPINKS.

There is a type of rot of frequent occurrence among cider apples which has hitherto received little notice. The apples suffering from this rot are very conspicuous, being entirely black, and in the comparatively early stages of the rot they are firm, smooth, and show no sign of shrinkage. No trace of fungus is to be seen on the outside of the fruit. On cutting open the apple the black colour is seen to be situated only in or near the skin, while the flesh is dark brown in colour, firm, and rather leathery and dry. On keeping, the apple very gradually dries and shrinks, but no soft- or wet-rot appears : affected fruit which has been kept for over a year is now quite hard, the flesh is dry and spongy, and the skin has the consistency of leather or hard rubber : if dropped, such a fruit bounces like a celluloid ball. Microscopic examination of a fairly fresh specimen showed that the whole apple was full of a fungus mycelium. Plates of malt-extract gelatine were inoculated with portions of the infected flesh removed under sterile conditions, and in each case a pure culture of *Monilia fructigena* was obtained.

In order to try to produce the black rot by artificial inoculation several apples of different varieties were punctured with a needle bearing spores from the above pure cultures. At the same time other apples were inoculated in a similar way with the spores of *Monilia fructigena* obtained from the fructifications on an apple affected with the typical brown rot. Of the infected fruit some developed the black rot, others the typical brown rot, and others a rot which was intermediate in character ; but it seemed as though the type of rot depended, not on the source of the fungus which produced it, but on the variety of apple on which the inoculation was made.

A more extensive series of inoculations was therefore made. Two sets of fruit were taken, each set containing apples of the same eight varieties : one set was inoculated with the *Monilia* obtained from an apple with black rot, the other with brown rot *Monilia*. A week after inoculation differences in the type of rot which was occurring could be seen ; in a fortnight the differences were still more marked ; while in three weeks, when no further change in their appearance was taking place, the apples could definitely be classified

according to the type of rot. It was then found that the apples of certain varieties all showed the black type of rot, those of other varieties the brown type, while others had an intermediate kind of rot : but the kind of rot produced in a certain variety of apple was quite independent of the source of the *Monilia* with which it was infected.

Apples of four varieties were next inoculated with *Monilia* from six different sources. The first strain of fungus was obtained from a black apple which had itself been inoculated with fungus from a black apple ; the second from a black apple inoculated from a brown apple ; and the third from a gelatine culture of fungus from a black apple. The sources of the fourth, fifth, and sixth strains were respectively brown from brown, brown from black, and gelatine from brown. But in every case it was found that the apples of the same variety showed the same type of rot irrespective of the fungus with which they were infected.

As it now seemed certain that the type of rot produced in an apple by *Monilia fructigena* depended only on the apple itself, the source of the fungus used in later inoculations was not noted : but it was, in fact, almost always taken from the fructifications on typically brown-rotted apples, as these were always convenient.

A further series of infections was now made on ten varieties of apples, four separate sets, each containing several individuals of each variety, being used. One set was kept in a laboratory at a temperature of about 15°C. and in an atmosphere of the normal humidity, a second set being in the same room but in a saturated atmosphere under a bell-jar : the other two sets were in normal and saturated atmospheres respectively in a room where the temperature was about 11°C. It was found that the general results were the same as before, certain kinds of rot always appearing in certain varieties of apple. The lower temperature had the effect of delaying the growth of the fungus so that the rot was slower, but the final result was the same as in the higher temperature. Increased humidity encouraged the growth of fructifications of the fungus, but had no other effect.

Inoculations on a number of individuals of five previously untried varieties of apple again showed that the type of rot depended on the variety of apple. The chief varieties of apples tested, and the kind of rot produced in each are as follows :—

Médaille d'Or	}	Quite black, firm, unwrinkled ; fructifications absent or very rare. Typical black rot.
Yeovil Sour		
Harry Masters		
Strawberry Norman		
Cowarne Red	}	Quite or mainly black, tendency to softening and shrinkage ; fructifications sometimes occurring in moderate numbers.
Dabinett		
Knotted Kernel		
Fréquin Audièvre		
Sweet Alford		
Cap of Liberty		

Dove	}	Some blackening, softening and shrinkage common ; fructifications usually numerous.
Doux Amer		
<i>Gascoigne's Scarlet Seedling</i>		
Eggleton Styre		
Reinette Obry	}	No blackening, fruit soft and shrunken ; fructifications usually very numerous. Typical brown rot.
Cremière		
<i>Court Pendu Plât</i>		
<i>Allington Pippin</i>		
<i>King's Acre Pippin</i>		
<i>American Mother</i>		

A satisfactory explanation of the different effect produced by *Monilia fructigena* in different varieties of apples has yet to be found. It will be seen from the above list of varieties tested, in which the market varieties are shown in italics, that the brown type of rot appears usually on apples of that class, while the black rot generally occurs on cider apples, especially on those of the bitter-sweet class.

This suggested that the black rot is produced in apples which contain a small percentage of acid but a large percentage of tannin : but the above list shows a number of exceptions to any rule based on such an assumption. Another suggestion is that the kind of rot produced depends on the mechanical texture of the apple, those varieties subject to black rot usually having a leathery texture, while brown rot generally occurs in fruit having a crisp flesh. The difference in texture of the flesh may be dependent on the structure or chemical composition of the cell-walls.

Further investigations are being made into the nature of the blackening and into the factors which determine which type of rot is produced in an apple attacked by *Monilia fructigena*.

A BACTERIAL DISEASE OF THE GOOSEBERRY.

BY B. T. P. BARKER AND OTTO GROVE.

In April, 1915, specimens of diseased gooseberry bushes were forwarded to the Station for examination from the Ross district of Herefordshire. The grower reported that he had found in his plantations a considerable number of bushes similarly affected, and that the disease appeared to be a new one in the locality.

The plants submitted for examination were young bushes which had just started growth for the season. The buds had burst and the young foliage was on the point of expansion. In some cases the developing foliage of the bush as a whole appeared to be perfectly healthy and normal except above a definite point on one or more shoots. On these all the leaves above this point, after having partially expanded, had suddenly wilted and were in a dying condition. Other bushes showed the same kind of trouble to a greater degree. In these cases either the whole of the foliage of the bush was affected, or the attack was localised in one or more of the main branch systems of the plant. In all cases where the attack was a partial one there was a sharply marked limit on the plant between the healthy and the diseased parts: below a definite point the growths were vigorous and normal, and above that point every developing bud on the particular branch-system concerned was dead, or dying.

It was inferred from this that the cause of the trouble was not at the root of the plant, but was likely to be found in the zone immediately above the highest healthy growth on the part of the bush affected. A closer examination of the plants confirmed this inference. On the removal of the outer tissues of the main stem and branches a sharply marked distinction was seen between the healthy and diseased parts. The colour of the inner tissues external to the wood was in the latter case a characteristic bluish-green, while in the healthy regions it was normal. There was no gradual transition of one colour into the other at any point, the dividing line being sharp. The distribution of the colour varied somewhat on different diseased shoots. On young shoots it sometimes extended for a considerable distance towards the apex of the shoot,

possibly reaching the tip : but the actual extent in such instances was generally obscured owing to the discoloration resulting from the death of the branches. On older branches and on the main stem the tendency was for the distribution to be comparatively limited in extent, the portion of the branch between the zone of colour and the apex of the shoot being relatively normal in appearance. A series of sections taken at different parts of the plant was then made and microscopically examined. In no case was any sign of fungus growth observed in the tissues. In every case, however, where longitudinal sections were made in the critical zone through the colour dividing line, the presence of numerous bacteria in the region of that line was clearly observed. This was the only point at which they were distinctly visible. Higher up on the diseased shoots the dessication of the tissues and the degeneration of the cell-contents into opaque substances prevented satisfactory observation.

Attempts were then made to isolate the bacteria, separate cultures being prepared from several plants. In handling the infected material the usual precautions against external contamination were taken. No difficulty was found in obtaining pure cultures, since only one kind of organism developed. This appeared in all the cultures from the different plants. It was a rod-like bacterium, actively mobile in young cultures on beer-wort gelatine. In plate cultures on this medium the colonies developed rapidly, becoming visible to the naked eye in three days. Their appearance was very characteristic, the surface colonies being liquid with smooth edges, round, concave, moist and glistening, semi-transparent, often with small white nuclei in the centre and concentric rings of granular matter beyond, and with whitish margins. In all respects they resembled exactly the colonies of the bacillus which causes the disease of fruit blossom described by the authors in their paper on that subject in the *Annals of Applied Biology*, Vol. I, No. 1. The liquefaction of the gelatine medium extended as rapidly and as completely as in the case of the latter organism; and, in addition, such cultures possessed the pronounced smell of ammonia which was so marked in the liquefied gelatine cultures of the fruit blossom bacillus. The size and form of the individual cells of the organism as well as their motility and the behaviour of the latter character in relation to aëration, also closely corresponded with those characters of the latter bacterium. It therefore appears that the two organisms are closely related, if not actually identical : but the examination of the cultural characters of the former has not yet been carried far enough to permit of a more positive statement as to identity. In this connection it is interesting to note that the fruit blossom bacillus was found by the authors on discoloured gooseberry blossoms during the course of their work on that pest.

Pure cultures of the bacterium having been obtained, a series of inoculations on young gooseberry plants in pots were made. The inoculations were made in various ways, and individual plants were kept under a variety of conditions. In no case did any sign of disease appear.

The failure of these infection experiments does not necessarily prove that the organism is not the cause of the disease. In many instances of plant diseases of bacterial origin inoculation experiments fail unless the exact conditions requisite for successful infection obtain: and it is possible that in this case something of this nature was at fault. The relationship of the organism to the fruit blossom bacillus renders this suggestion particularly likely, since it is known that the appearance and intensity of the fruit blossom disease depend primarily upon the prevailing weather conditions. The invariable presence of the bacterium in the tissues of the plant showing the earliest sign of disease, the local distribution of the infected areas on the plant in the earlier stages, and the entire absence of any other organism in the newly diseased tissues, constitute cumulative evidence of considerable weight that the bacterium in question is an active parasite causing the disease. At the same time it seems probable that outbreaks are determined mainly by other factors—possibly weather conditions—which affect the constitution of the host and render it susceptible or resistant as the case may be.

STRAWBERRY STOCK EXPERIMENTS.

BY B. T. P. BARKER.

In the spring of 1913, when a new plantation of small fruits was established at the Institute, a series of experiments with Royal Sovereign strawberry plants was started. The main object of the experiments was to determine if the locality from which the runners were obtained influenced in any way the subsequent growth of the plants and their cropping qualities. It has already been conclusively established in the case of potatoes that the district from which the "seed" is obtained has a marked effect on the size of the resulting crop: and it was thought possible that something of the same kind might occur with strawberries.

The plot of ground selected for the experiment was about one quarter of an acre in extent. It was planted at the same time with young black currant bushes, in rows at 5 feet apart, the rows of strawberries alternating with those of the currants. The distance between individual strawberry plants in the rows was 2 feet, there being 100 plants in each row. The whole of a single row of plants were obtained from the same nursery, the plants being runners taken during the previous summer. Each row was obtained from a different nursery, the sources being selected so as to represent as many widely separated districts or types of soil of the British Isles as possible, while in two cases the plants were obtained from Jersey and the Orleans district of France respectively. Altogether there were 12 rows, representing the same number of different localities.

The plants were not allowed to bear any fruit in 1913: but good crops were produced in 1914 and 1915, statistics of the yields being given in the following table. Unfortunately in the latter year, before picking had been quite completed, the small proportion of the crop left ungathered was completely ruined by the severe hailstorm of July 4th, and the weights given do not, therefore, quite indicate the actual size of the crop: but, so far as could be judged, each row was affected to about the same proportionate degree, and the crop weights given for 1915 can, probably, be compared with one another without serious error. It had been originally intended to continue the experiment to 1916 for a third

season of cropping: but the growth of the currants with which the strawberries were interplanted rendered it undesirable. The results of the experiment are, therefore, based on the crops from the plants in their second and third seasons, the actual weights being given in the table on the opposite page.

The figures given for the plants from Norfolk and Scotland are, undoubtedly, lower than they would have been, had these plants been put out at the same time as the remainder. They were planted later owing to a new drain passing across that part of the plantation not being completed in time. The French strain was impure, and the results are thus not strictly comparable with the others. The results, as a whole, show unexpectedly large differences between the individual strains, the Jersey plants being far ahead of the remainder in both seasons; but even if this be considered an abnormal case, there still remain relatively large and important differences between the others. One point seems clearly brought out, this being that the heavier croppers in 1914 by no means invariably retained their superiority in the following year.

The difficulties of obtaining consistent results in experiments on strawberries are well recognised by those who have had experience with them: and it is not intended here to attempt to draw any positive conclusions from the present series of experiments. They should be regarded as in the nature of a preliminary trial, which has yielded results of a decided character; and the consideration of the real bearing of the latter may be left until the results of supplementary experiments are available. A case for further investigation has certainly been established, and this is already in progress.

Source of Plants.	Weights of Crop in lbs.		
	1914	1915	Total.
Devon	187 $\frac{7}{8}$	57 $\frac{1}{2}$	76 $\frac{3}{4}$
France	21 $\frac{1}{16}$	43	64 $\frac{1}{8}$
Hampshire	21 $\frac{1}{2}$	47 $\frac{3}{4}$	69 $\frac{7}{8}$
Hereford	19 $\frac{5}{16}$	42	61 $\frac{5}{8}$
Ireland	16 $\frac{7}{16}$	55 $\frac{1}{2}$	71 $\frac{1}{6}$
Jersey	39 $\frac{3}{8}$	83 $\frac{1}{2}$	122 $\frac{3}{4}$
Kent (mid.)	23 $\frac{1}{2}$	52 $\frac{3}{4}$	76
„ (south)	16 $\frac{1}{16}$	71 $\frac{1}{2}$	88 $\frac{7}{16}$
Norfolk	10 $\frac{1}{2}$	34 $\frac{1}{2}$	45
Scotland	15 $\frac{1}{2}$	58 $\frac{1}{2}$	74 $\frac{5}{8}$
Yorkshire	19 $\frac{1}{16}$	47	66 $\frac{1}{16}$
„	20 $\frac{1}{16}$	55	75 $\frac{1}{16}$

NOTES ON APPLE STOCK INVESTIGATIONS.

BY B. T. P. BARKER AND G. T. SPINKS.

In the last report of the Institute a preliminary account was given of the work which had been started in connection with apple stocks, especially those of the "free" and "crab" classes: the following is a summary of the progress of these investigations up to the present time.

In the spring of 1914 examination was made at Long Ashton of a large number of crab and free stocks which have been collected from various sources. The root system of these stocks varies very widely. The two extreme types found are, in the one case, a root system which consists almost entirely of a few little-branched strong roots of the tap-root type, lacking in fibre and laterals. At the other extreme there is little sign of any coarse tap-root growth, the root system consisting almost entirely of a mass of fine fibres given off from the base of the stem and from the original weakly-developed main root. Between these two types all grades of variations have been found. There are coarse-rooted types, more branched than in the extreme cases, and showing rather more laterals and more fibre. Proceeding further in the scale, a stage is found in which the main roots are less coarse, the lateral system more strongly developed, and the fibres more numerous. In other cases the development of laterals is the striking feature, the main root system being comparatively little developed. Further along the scale a type is reached in which the laterals, although very numerous, are less strong, and a very large development of fibre is present. In such cases there is very little evidence of any main root system. Undoubtedly, the most interesting types at present are those in which the roots consist of a mass of fibrous roots, which are given out both from the original main root and the base of the stem. Members of this class evidently approach the Paradise type very nearly, and it is possible that further experience will show that some of them may prove as useful as the types of Paradise stock more commonly used. A system of classification was devised, and the stocks were put in different classes in accordance with the different characters of their root systems. About eight classes were recognised.

In March, 1915, the same stocks were again examined, and it was:

found that, in general, the classification made in the previous year still held good after the stocks had made another year's growth. The character of the root system of each individual stock was noted, and special notice was taken of those which showed signs of stem-rooting. Root-cuttings were taken from the most promising members of each class, and a large number of these have grown successfully. On re-planting the stocks the stems were cut back to about nine inches from the ground, and were earthed-up in summer after the growth of the lateral shoots: by this means stem rooting was encouraged, and hence it was possible, after further examination, to pick out the stocks which seem likely to strike readily from cuttings and layers. Observation of the most promising stocks of various types, and attempts to propagate them, will be continued this year.

SOME EXPERIMENTS ON FRUIT AND VEGETABLE BOTTLING.

BY B. T. P. PARKER.

At the suggestion of the Board of Agriculture and Fisheries experiments on the bottling of fruits were carried on during the summer of 1913, the primary object being to devise an inexpensive and simple method of bottling for home use and to obtain further information concerning the temperature and time of heating necessary for sterilization.

Experimenting with ordinary jars and bottles.—The method of bottling fruit in water or syrup in bottles of special construction is well known, and has been described in a paper No. 216, issued by the Board of Agriculture. The special types of bottles mentioned involve, however, some initial outlay, and the cost amounts to a serious one if it is desired to do much bottling. An attempt has therefore been made to devise a method whereby ordinary earthenware or glass jars or bottles could be used.

The method developed by Mr. H. E. Howman, which was described in the Report of the Institute for 1907, as a thoroughly satisfactory one and enables the operator to use ordinary water-purified jars and bottles, provided that the jars are without serious flaw. It requires, however, a suitable clamp and a supply of lids and rubber bands.

A method which has been hitherto frequently used in the home with more or less success consists in covering the fruit or water in the ordinary way, either by heating the jars or bottles in an oven or by a vessel of boiling water, and, when the process of sterilization is completed and the bottles removed, then pouring, running hot or to the surface of the water as it is now, what will be a solid block of fat of some thickness to the neck of the bottle.

Wax, fat, however, is not an ideal substance to use as a seal for the bottle. Experiments have themselves been made to find a more suitable substance. Paraffin was chosen for trial. This material has the advantage of being absolutely harmless and not liable to decomposition. It failed to give satisfactory results, however, owing to the contraction of the liquid in the bottle on cooling, the

paraffin plug became loosened in the neck and the perfect seal, which is absolutely necessary, was therefore broken. Another drawback was that the wax, being a relatively hard substance, failed to adhere closely to the glass sides of the neck of the bottle, and showed an invariable tendency to contract away from them.

A softer type of wax was, therefore, next tried. In this case the wax used was one made by melting up together paraffin wax and vaseline in proportions of 3 ozs. of the former to 1 lb. of the latter. The results with this material were much more satisfactory than with the paraffin wax alone. Being comparatively soft and plastic, it adhered better to the neck of the bottle and thus made a closer seal. In order to get thoroughly satisfactory results, however, it was necessary to apply the material gradually. The best plan found was to cover the liquid in the neck of the bottle with some of the melted mixture immediately the bottle was removed from the heater. After cooling, a further quantity of the melted wax was then poured on to the original lot until sufficient was added to reach and slightly overlap the rim of the bottle. This had been wiped as dry as possible before the addition of the wax. A portion of the molten wax was spread over the rim so as to thoroughly cover the glass as far as the outer edge. When the bottles were sealed in this fashion, the contents generally remained perfectly sound indefinitely: but when the precaution to make a perfect seal between the wax and the rim of the bottle was neglected, there was a tendency for the liquid in the bottle gradually to creep up between the glass and the edge of the wax plug, and eventually to find its way to the surface of the seal. When this occurred, sooner or later mould began to grow in the thin film of liquid exposed, and eventually found its way to the contents of the bottle, which were thus spoiled. In such cases, however, the seal usually remained efficient for two or three months at least. When it is a question merely of bottling the fruit for temporary purposes, the method is adequate.

In order to counteract the tendency of the seal to contract from the rim of the neck of the bottle and thus to allow of the entry of moulds into the latter, an endeavour was made to check the growth of these organisms at the weak spots around the edges of the seal by painting the surface of the wax with a saturated solution of borax as soon as the seal had set after application. This treatment gave very good results and very few cases of mould development occurred. It also had a tendency to render the surface of the seal harder and thus more convenient to handle. Without the coating of borax the consistency of the seal was somewhat on the soft side.

The difficulty of obtaining a perfect seal, either with waxes of the kind mentioned above or with mutton fat, is due to the fact that a film of moisture adheres to the sides of the neck of the bottle or jar, and the wax or fat is thus never actually in contact with

the glass surface and cannot, therefore, adhere properly. The bottles heated in a dry oven gave equally unsatisfactory results in this respect as those that were sterilised in a vessel of water.

An effective method of dealing with this tendency of the wax or fat to fail to adhere to the glass was found when a seal made with ordinary paraffin wax was covered with about $\frac{1}{4}$ inch of liquid paraffin. In this case the quantity of wax added was limited so as to leave sufficient room in the neck of the bottle for the liquid paraffin, which was added after the wax seal had set.

There is no reason why the use of seals such as those described above should not answer perfectly well for domestic purposes, provided that the bottles are looked over from time to time and any showing a tendency to mould growth at the edges of the seal used without delay. Fruit can by this means be kept in a thoroughly sound condition for months without any serious trouble in its preparation or attention afterwards being necessary.

The old method of tying a piece of bladder over the neck of the bottle is fairly satisfactory ; but it is impossible to fasten it on airtight, and it is therefore not mould-proof. Better results have been obtained using ordinary parchment paper jam-covers pasted or gummed on, provided that the bottles were afterwards kept in a cool, dry place and the covers affixed while the contents of the bottle were still hot. This method gives very fair results.

Experiments on the method of sterilisation.—The usual method of sterilisation adopted in the above experiments was on the lines of that recommended in the leaflet referred to. The fruit was placed in bottles, covered with cold water and the bottles then placed in a vessel of cold water which was gradually heated until the temperature reached about 68°C. (140°F.) When the contents of the bottles reached that temperature, they were kept at that point for 20 minutes and then removed from the steriliser. This treatment has throughout all the experiments made given thoroughly satisfactory results, so far as the keeping properties of the fruit were concerned.

In certain cases, however, the question of the temperature used and the length of time of application are of importance on account of the tendency of certain types of fruit to split or become disintegrated, and for loss of colour to occur. A series of experiments was therefore made in which time of heating and the temperature were varied.

In the first set the temperature to which the fruit was heated was 68°C., but the length of time of application varied. The kind of fruit used was the Superlative raspberry. Some bottles were raised to that temperature in the steriliser, and, immediately it was reached, removed and allowed to cool. Others, after reaching that point, were kept there for 5, 10, 20, 30 and 35 minutes respect-

ively. In all cases except those where the bottles were removed immediately the temperature limit was reached, the sterilisation was perfect. It is possible that in these cases also the fruit was properly sterilised, but owing to an unsatisfactory seal the bottles treated in this way eventually showed mould growth and the results, therefore, were interfered with. As regards colour, all the bottles showed very fair results, the best probably being those heated for 10 minutes. The condition of the fruit was equally good throughout.

Black currants and loganberries were also subsequently treated in the same way with corresponding results.

In the second series of experiments on the method of heating, the temperature at which the fruit was sterilised was varied. The bottles in the respective tests were brought to temperatures of 60, 64, 68, 76 and 88°C. When these temperatures were reached in individual cases, the bottles were allowed to remain at those points for 20 minutes and then removed and allowed to cool. The Superlative raspberry was the fruit used. In this series all bottles were equally well sterilised and the condition equally good. The only difference distinguishable was that there was a tendency for the colouring of the fruit to get rather "washier" at the higher temperatures used.

In the case of plums the treatment and maximum point of temperature were varied slightly. The bottles were heated to a temperature of 71°C.; and instead of the fruit being bottled in water it was conserved in a thin syrup, which was poured on the fruit while still hot. The variety of fruit used was Pond's Seedling, and the bottling was done on August 9th, while the fruit was still green and hard. The times of heating adopted were 10, 20, 30, 40 and 45 minutes respectively, at 71°C. In every case the fruit kept perfectly well.

In other experiments with plums the standard method of sterilisation used was to place the plums in cold water in the bottles and then raise the bottles in the steriliser gradually to 71°C., taking about one hour to bring the temperature to that point and leaving them for 45 minutes at that temperature. The sterilisation in this case was invariably successful, but in view of the results just quoted the length of time of heating was clearly unnecessary.

In the case of plums of the Gage type, such as Early Transparent Gage and Denniston's Superb, the fruit was brought to a temperature of 68°C., and heated for 30 minutes only at that point. Sterilisation in these cases was also perfect.

In view of these results it seems clear that the temperatures which have hitherto been recommended for sterilising, and also the times of heating, are in many cases unnecessarily high. With small fruits, such as raspberries and currants, it is evident that there is no occasion to use a higher temperature than 60-65°C. (140-150°F),

nor a longer exposure at that temperature than from 5 to 10 minutes. In the case of stone fruits, like plums, probably a rather higher temperature and a longer heating are desirable, but if the temperature of the steriliser is raised slowly there appears to be no occasion for heating the fruit for longer than 10 minutes at 71°C. (160°F.).

Trials of Varieties of Raspberries for Bottling.—It is known that certain varieties of raspberries have a tendency to bottle more satisfactorily than other sorts, and a comparative trial of several varieties grown at Long Ashton was therefore carried out. The varieties tested were as follows :—

Abundance
Bath's Perfection
Bunyard's Profusion
Hornet
Lord Beaconsfield
Semper Fidelis
Steele's Victoria
Superlative

The bottles in each case were heated for 20 minutes at 68°C. The chief variation in the results for the different varieties was in the colour. In a few cases the colour was very well kept, but in most it was rather badly washed out from the fruit and partially destroyed. The best coloured samples were Semper Fidelis and Profusion. Bath's Perfection and Superlative were also fairly good; but with the remainder the colour was more or less washy. In most varieties the berries kept their form well and showed no tendency to break up. In most cases also there was no deposit formed nor haziness in the liquid. Placing the varieties in order of merit, Semper Fidelis was slightly the best, followed by Profusion and Hornet, which were equally good, with Superlative next best.

The Bottling of Plums.—It is generally difficult to bottle plums without obtaining some splitting of the fruit or peeling of the skin. In order to ascertain to what degree these drawbacks could be controlled by suitable treatment a number of trials of several varieties of plums were made, the varieties used being :—

Czar
Denniston's Superb Gage
Early Rivers
Early Transparent Gage
Pond's Seedling
Victoria

In most cases the sterilisation was performed in the manner described above, the fruit being bottled either in water or syrup.

In one test, however, the fruit was placed dry in jars in an oven, and heated there until the fruit showed signs of cracking. The

bottles were then removed, filled with boiling water to cover the fruit immediately, and sealed. The fruit treated in this way kept as well as that bottled by the other methods and was, perhaps, of slightly better flavour.

The results of the tests as a whole may be summarised as follows. When the fruit is bottled in an unripe condition, there is less tendency for splitting and for peeling of the skin than in the case of perfectly ripe fruit. In the case of plums of the Gage type the tendency for the skin to peel is evidently very much greater than with varieties such as Victoria and Pond's Seedling. Pricking of the fruit before bottling did not prevent this splitting.

Bottling of Vegetables.—Several experiments on the bottling of peas and runner beans were made, and a variety of methods tested. In no case were the results really satisfactory and, so far no method of bottling suitable for domestic work has given such good results as drying, in the case of peas, and salting, in the case of beans.

A variation of the latter method has been tried with very satisfactory results. Usually the beans, whole or sliced, are placed in an earthenware jar or pan, or other suitable vessel, in thin layers alternating with layers of salt. This treatment results in the gradual accumulation of scum and fluid above the surface of the beans, and on that account is open to some objection. If, however, the beans are sliced and the slices sprinkled with or rolled lightly in salt before being placed in the jar, there is no occasion to add any further salt. The slices can be packed tightly in the jar, and will remain dry and in excellent condition indefinitely. Washing for an hour in running water before cooking suffices to remove all the salt, and is all the preparation necessary.

EXPERIMENTS WITH HUMOGEN AND HEATED PEAT.

BY C. T. GIMINGHAM.

Much interest has been aroused among horticulturists during the past year in the work carried out by Professor Bottomley, of King's College, London, which has resulted in the production of a material called by its inventor "Bacterised Peat" or "Humogen." Great claims are made as to the results obtainable by the use of this prepared peat as a fertiliser. It is stated that in addition to soluble humates, Humogen contains nitrogen-fixing bacteria and accessory food bodies, constituents which are not to be found in other fertilisers. Accessory food bodies, in so far as they are concerned with plant nutrition, are the discovery of Professor Bottomley, who holds that they are essential for the proper development of plants since they provide a needed stimulus to growth. Very small quantities are sufficient to show this growth-stimulating action. For example, "an aqueous extract of the bacterised peat (1 part peat to 200 parts water) supplied all the plant food necessary for water-cultures with tomato, barley, and buckwheat seedlings"*; or again, "in an experiment with seedlings of *primula malacoides* potted up in loam, leaf mould, and sand, plants watered twice with the water extract of only 0.18 gm. of bacterised peat were, after six weeks' growth, double the size of similar untreated plants"* Undoubtedly if such results as these, together with the deductions made from them are finally confirmed, the possibilities are tremendous.

Before, however, these possibilities begin to materialise a large number of practical experiments are absolutely necessary, and, fortunately, during the year a good many trials have been carried out, the results of which are now becoming available. The details of some experiments on a small scale, with a sample of humogen kindly supplied by Mr. Machen, are given here as a contribution to the general body of evidence which is accumulating.

Tomatoes were used as experimental plants, and an opportunity

* See Rpt. Brit. Assoc. Trans. Sec. K 1912 : Jour. Roy. Soc. Arts, Vol. lxii, 1914
Ann. Botany, Vol. xxviii, July, 1914. Also Proc. Roy. Soc. B 602, Sept., 1914.

having arisen for obtaining a sample of ordinary peat which had been heated but not otherwise prepared, some series of plants treated with this material were included. The results, therefore, provide a comparison between "bacterised" peat and heated (but not "bacterised") peat.

The chief object held in view in planning the experiments was to obtain practical evidence as to the action of Professor Bottomley's accessory food bodies. Therefore in every case the soil mixture was made too poor by itself to grow a good crop of tomatoes in order to give the maximum opportunity for the "humogen" or heated peat to show any special stimulating properties. This accounts for the comparatively low yields of fruit obtained throughout. The soil employed was a rather stiff loam, not very rich in organic matter,

TABLE.

Series	Treatment	Yield in grams Plant A.	Yield in grams Plant B.	Yield in grams Plant C.	Average yield per plant in grams.
1	1lb. humogen per pot	1225	1259	1294	1259
2	4oz. "	446	355	482	427
3	1oz. "	455	388	422	421
4	1lb. heated peat	872	824	786	827
[5	4oz. "	236	300	455	330
6	Control: soil only	311	403	409	374]
7	2½lbs. stable manure per pot	683	730	709	707
8	2½lbs. stable manure per pot + two additions of humogen extract*	624	708	693	675
9	2½lbs. stable manure per pot + two additions of peat extract*	560	640	611	604
10	2½lbs. stable manure per pot + nitrate of soda ..		(7 plants)		1160

* The extracts were made by rubbing up 20 grams of the humogen or peat with a little water, the whole then being made up to 2 litres, and after thorough shaking allowed to stand overnight; the supernatant liquid was used at the rate of 300 c.c. per pot on June 1, and the same quantity of a fresh extract on July 1.

by no means an ideal tomato soil. The plants were taken from a uniform batch of one variety and potted about the end of May in 10-inch pots, each pot holding about 20lbs. of soil. Watering and general treatment were precisely the same for all throughout the experiment.

The following table gives the yields of fruit obtained by the various methods of treatment. Each series consisted of three plants and it will be seen that the weights of fruit from individual plants in the same series were, on the whole, in very good agreement, except in the case of Series 5.

The following notes made from time to time during the growth of the plants should be considered in connection with the final yields of fruit, as given in the table.

June 15.—From the first, Series 1 and 4 went much ahead of all the others, the plants being earlier in bloom, stouter, much darker green, and the leaves much less serrate: Series 4 distinctly bigger plants than Series 1. There was little to choose between Series 2, 3, 5 and 6, though all were distinctly better than Series 7.

July 1.—The differences between Series 1 and 4 and the remainder is still more marked, especially as regards colour, but now 1 is just ahead of 4 in the size of the plants. Series 2, 3, 5 and 6 remain about level but the difference between these and Series 7 is less marked than earlier.

July 10.—Series 1 is now markedly better in appearance than Series 4.

July 20.—Series 2, 3, 5 and 6 are now looking very yellow and starved as compared with Series 7.

Series 8 and 9 (extract added on June 1 and July 1) remained throughout indistinguishable from Series 7. Series 10 was also level with 7, 8 and 9 until the addition of the nitrate when the fruit was beginning to swell. After this point, Series 10 (which consisted of seven plants) looked very much healthier than any of the remainder. Series 1 and 4 became diseased and many fruits ripened very irregularly, and although the final weight of fruit from Series 1 was slightly higher than from Series 10, the weight of first-class marketable fruit was undoubtedly in favour of Series 10.

At the time the plants were potted:—

The sample of humogen contained	2.39%	nitrogen
“ “ heated peat	1.08%	“
The manure used	0.49%	“

The first point to notice about the figures in the table is that large doses of both humogen and heated peat have given large increases of yield over that obtained from the soil alone. Both materials, therefore, provide considerable quantities of plant food, the heated peat giving the best result per unit of nitrogen. But the use

of as much as 11b. humogen per pot will probably be out of the question in practice* and indeed (even if it were not) the same, or a better, result could easily be obtained by the ordinary methods of tomato culture—witness Series 10, in which the plants were grown in a soil mixture much less rich than that frequently used for tomatoes. There seems no reason to attribute the increase in yield to anything more than ordinary manurial properties.

With the smaller amounts of humogen the results are difficult to interpret. One ounce of humogen has apparently given as good results as 4 ounces, but the increase over the yield from soil only (Series 6) is not very great in any case, and is certainly within the limits of experimental error.

Coming now to Series 8 and 9 and comparing the yields with those from Series 7, we find that the treatment with the water extract of humogen or peat has given no increase whatever. As noted above the plants in these three series grew very evenly throughout, and gave remarkably close final yields of fruit. Moreover, after the earlier stages of growth these plants were healthier in appearance than any in Series 1–6, no doubt due to the presence of the manure. There is no evidence here of the action of any kind of growth-stimulating substances either in the humogen or in the heated peat.

It is not desired to stress the results here recorded, because the experiments were of necessity on a small scale, but so far as they go the results do not confirm the claims put forward that humogen possesses special fertilising powers by virtue of the presence of growth stimulants.

* It has been stated that the probable price of humogen will be in the neighbourhood of £10 per ton.

THE COMPOSITION OF MANGELS GROWN IN THE BRISTOL PROVINCIAL COUNCIL MANGEL VARIETY TRIALS, 1915.*

By C. T. GIMINGHAM.

At the request of the Sub-Committee on Joint Field Demonstrations, analyses were made of samples of the mangels grown in these trials. The number of centres at which plots were laid out was eight: two in each of the counties of Gloucester, Hereford, Somerset, and Worcester. At each centre the following six varieties were grown:—Garton's Golden Globe, Sutton's Golden Tankard, Garton's Red Globe, Webbs' Red Intermediate, Webbs' Lion Intermediate, and Sutton's Prizewinner. The Agricultural Organisers of the respective counties undertook the field work in connection with the trials; and the details with regard to soil, manure and previous cropping are given in Table IV.

Samples were taken from each plot at each centre, and determinations of dry matter and of sugar were made on all the samples. With slight modifications, the methods adopted both for sampling and making the determinations were those recommended by Wood and Berry in their work on "Variation in the Chemical Composition of Mangels" (*Journal of Agricultural Science*, Vol. I., p. 176). The samples were obtained by means of specially made corers, cores being taken from 50 roots in each plot in order to obviate the error due to variation in individual composition which would be almost certain to arise if only a small number of roots is sampled. Wood and Berry found that by taking 50 roots the error in the determinations was reduced to ± 0.2 per cent. or under. The cores were taken horizontally through the greatest diameter of the root which is "the region where variation in composition is least pronounced." The bundles of 50 cores from each plot were wrapped in butter paper, and conveyed to the laboratory in air-tight tin boxes. In all cases (except the samples from Herefordshire) the determinations were made on the day following sampling.

* A leaflet summarizing the results of these trials is obtainable on application to the Secretary, University of Bristol Agricultural and Horticultural Research Station, Long Ashton, Bristol.

For analysis the cores were cut in half, half being used for the estimation of dry matter and half for the estimation of sugar.

Dry Matter.—The samples were weighed on aluminium plates, and dried for 10–14 days on hot water pipes at a temperature of about 50°C., the drying being finally completed by two days in an oven at about 60°C. No charring whatever was observed.

Sugar.—The samples were ground in a sausage mill and then pressed to obtain the juice. The requisite quantity of juice was measured (after skimming off the froth), clarified with basic lead acetate and filtered. The filtrate was then polarised both before and after inversion, and the percentage of total sugar calculated from the rotations observed. The percentage of sugar in the juice was converted into percentage in the root by the use of the factor 0.93 (Wood and Berry). It may be of interest to note here that the clarified juice of the two yellow-fleshed varieties—Sutton's Golden Tankard and Garton's Golden Globe—was of a clear golden-yellow colour, whilst in the case of the two red varieties it was colourless, the pigment having been precipitated by the basic lead acetate. This precipitation of pigment was observed by Wood and Berry in the case of all "Long Red" mangels.

The analytical figures and the yields are given in Table I. The varieties are there placed in order of merit, so far as average *quality* is concerned, the same order applying to the percentages of both dry matter and sugar. As is always the case in experiments of this kind, there is considerable variation in the composition of the same variety at different centres, due probably to differences in soil, manuring, cultivation, etc. Nevertheless, in every case the six varieties are found to divide themselves into two distinct groups as regards quality. At each centre the first three—Garton's Golden Globe, Sutton's Golden Tankard, and Garton's Red Globe—have given crops of very distinctly higher quality than the last three. If we take the two extremes—Garton's Golden Globe and Sutton's Prize winner—the average difference in dry matter amounts to nearly 2½ per cent., which means that a 40-ton crop of the former provides as much food as a 50-ton crop of the latter.

From the practical point of view, however, the matter of special importance is not, which is the variety of highest food value, but which variety yields the greatest amount of *food per acre*? Some figures giving information with regard to this are given in Tables II. and III. In Table II. the weight of dry matter produced per acre is calculated for each variety at each centre, whilst Table III. summarizes these results, and in the second and third columns gives the average figures for the production of dry matter and of sugar at all the centres.

It will be seen at once that the two varieties of highest quality give the poorest crop, with the result that the average production of

dry matter and of sugar per acre is low. On the other hand, the variety of poorest quality—Sutton's Prizewinner—has not, in these experiments, made up for its low feeding value by giving the biggest crop, and the average amount of dry matter per acre is the same as with Garton's Golden Globe, whilst the sugar is lower. Intermediate come the two red mangels (Garton's Red Globe and Webbs' Red Intermediate) and Webbs' Lion Intermediate, with good cropping power, and of very fair quality.

As a general result, these three have undoubtedly, proved themselves in these trials, the best varieties to grow in order to obtain the highest yield of food per acre. There is not a great deal to choose between them, the order in which they come varying at the different centres, and as the results refer to one season only, the small differences in the average figures are probably not significant.

With regard to the details at the individual centres, if Table II. is examined, it will be seen that the most serious divergence from the order in which the average figures come is shown at the Winchcombe centre. Here the varieties of high quality yielded unusually well, and give the highest production of dry matter per acre. This is probably to be explained by the fact that at this centre a very large dressing of nitrate of soda was given in addition to heavy dunging, and has evidently had great effect in increasing the cropping power of the better quality varieties. With this exception the divergencies from the general order are not very great.

In view of the high production of dry matter shown by the two red varieties in these trials, it is interesting to find that, in the extensive investigations of Wood and Berry, in the Eastern counties, "Long Red" strains gave the highest yields of dry matter per acre. Whether the red varieties grown in these trials are related to "Long Reds" it is difficult to say, but the non-precipitation of the pigment by lead acetate, as noted above, may possibly indicate some connection.

A general comparison of the same varieties in the two sets of experiments shows on the whole rather poorer quality, but somewhat bigger crops for roots grown in the South-west counties. No doubt this is connected with the general difference in rainfall.

TABLE I.

		Yield, Tons per acre.	% Dry matter	% Sugar.
GARTON'S GOLDEN GLOBE.				
Winchcombe, Gloucestershire	..	41.06	12.01	7.61
Tibberton, Gloucestershire	..	35.0	13.44	8.98
Webton Court, Herefordshire	..	26.9	11.19	6.1
Chipp's House, Herefordshire	..	23.5	12.74	7.08
Chisleborough, Somerset	..	32.0	11.98	7.33
Hambridge, Somerset	..	27.5	11.47	7.15
Malvern Wells, Worcestershire	..	27.5	13.47	8.3
Stockton, Worcestershire	..	29.95	11.19	6.94
Average (8 centres)	..	30.4	12.19	7.44
SUTTON'S GOLDEN TANKARD.				
Winchcombe, Gloucestershire	..	43.5	13.02	8.26
Tibberton, Gloucestershire	..	36.65	13.03	8.21
Webton Court, Herefordshire	..	25.8	12.11	5.60
Chipp's House, Herefordshire	..	33.15	11.53	6.39
Chisleborough, Somerset	..	27.71	11.58	6.74
Hambridge, Somerset	..	22.62	13.0	7.35
Malvern Wells, Worcestershire	..	26.55	12.44	7.74
Stockton, Worcestershire	..	34.45	10.19	5.76
Average (8 centres)	..	31.3	12.1	7.01
GARTON'S RED GLOBE.				
Winchcombe, Gloucestershire	..	50.35	9.76	5.6
Tibberton, Gloucestershire	..	49.8	12.12	8.03
Webton Court, Herefordshire	..	36.65	10.66	5.2
Chipp's House, Herefordshire	..	33.55	10.83	6.13
Chisleborough, Somerset	..	40.35	10.55	6.42
Hambridge, Somerset	..	26.5	11.62	6.96
Malvern Wells, Worcestershire	..	29.5	12.61	7.79
Stockton, Worcestershire	..	37.65	9.82	5.91
Average (8 centres)	..	38.2	10.99	6.51
WEBBS' RED INTERMEDIATE.				
Winchcombe, Gloucestershire	..	48.5	10.03	5.33
Tibberton, Gloucestershire	..	42.0	11.98	7.74
Webton Court, Herefordshire	..	40.15	9.57	5.22
Chipp's House, Herefordshire	..	40.85	10.38	5.93
Chisleborough, Somerset	..	51.15	10.13	5.74
Hambridge, Somerset	..	32.71	10.34	5.83
Malvern Wells, Worcestershire	..	29.20	11.6	6.67
Stockton, Worcestershire	..	34.65	9.0	5.36
Average (8 centres)	..	39.9	10.38	5.98
WEBBS' LION INTERMEDIATE.				
Winchcombe, Gloucestershire	..	50.0	9.37	5.13
Tibberton, Gloucestershire	..	44.56	11.95	7.5
Webton Court, Herefordshire	..	39.40	10.31	5.02
Chipp's House, Herefordshire	..	38.90	9.43	5.26
Chisleborough, Somerset	..	41.21	9.91	5.5
Hambridge, Somerset	..	27.0	10.34	5.93
Malvern Wells, Worcestershire	..	30.5	11.83	6.73

TABLE I.—*continued.*

	Yield. Tons per acre.	% Dry Matter	% Sugar.
WEBBS' LION INTERMEDIATE—<i>continued</i>			
Stockton, Worcestershire	35·3	8·88	5·04
Average (8 centres)	38·4	10·25	5·78
SUTTON'S PRIZEWINNER.			
Winchcombe, Gloucestershire	46·4	9·25	4·76
Tibberton, Gloucestershire	45·92	11·66	7·47
Webton Court, Herefordshire	37·10	9·41	3·98
Chipp's House, Herefordshire	37·0	10·03	5·29
Chisleborough, Somerset	38·35	9·57	5·2
Hambridge, Somerset	34·1	9·5	5·44
Malvern Wells, Worcestershire	28·15	9·89	5·17
Stockton, Worcestershire	34·75	9·13	4·97
Average (8 centres)	37·7	9·8	5·28

TABLE II.
DRY MATTER PER ACRE IN TONS.

Centre.	Variety.					
	Garton's Golden Globe.	Sutton's Golden Tankard.	Garton's Red Globe.	Webbs' Red Inter- mediate.	Webbs' Lion Inter- mediate.	Sutton's Prize Winner.
Tibberton, Glos. ..	4·70	4·77	6·04	5·03	5·33	5·36
Winchcombe, Glos. ..	4·93	5·66	4·91	4·86	4·68	4·29
Webton Court, Hereford.	3·00	3·12	3·90	3·84	4·06	3·49
Chipp's House, Hereford.	2·99	3·82	3·63	4·24	3·67	3·71
Chisleborough, Som. ..	3·83	3·21	4·26	5·18	4·08	3·67
Hambridge, Som. ..	3·15	2·94	3·08	3·38	2·79	3·24
Malvern Wells, Worcs.	3·7	3·30	3·72	3·39	3·61	2·78
Stockton, Worcs. ..	3·34	3·51	3·70	3·12	3·13	3·17

TABLE III.

Variety.	Average yield tons per acre.	Average Dry Matter per acre. Tons.	Average Sugar per acre. Tons.
Garton's Golden Globe ..	30·4	3·7	2·3
Sutton's Golden Tankard ..	31·3	3·8	2·2
Garton's Red Globe ..	38·2	4·2	2·5
Webbs' Red Intermediate ..	39·9	4·1	2·4
Webbs' Lion Intermediate ..	38·4	3·9	2·2
Sutton's Prizewinner ..	37·7	3·7	2·0

TABLE IV.

Centre.	Kind of Soil.	Previous Cropping.	Manuring per acre.
Tibberton, Glos. ..	Heavy loam with clay subsoil	Wheat	20 loads dung, 8cwt. special mangel manure
Winchcombe, Glos. ..	Heavy loam with clay subsoil	Wheat	30 loads dung, 2½cwt. nitrate of soda
Webton Court, Hereford	Medium loam	Turnips	1cwt. super, 6cwt. slag, 4cwt. salt
Chipp's House, ,, ..	Clay loam	Oats	Dung and Compound Artificial Manure
Chisleborough, Som. . .	Sandy loam on Midford sand	Swedes fed off by sheep	
Hambridge, ,, ..	Clay loam on lias	Ditto	Dung
Malvern Wells, Worces.	Clay loam, mixed with gravelly detritus	Beans	12 loads dung, 3cwt. raw bone flour, 4cwt. super and 1½-2cwt. nitrate
Stockton, ,,	Strong loam, with stony subsoil	Wheat	15 loads dung, 5cwt. special mangel manure, 2½cwt. super, 4cwt. salt 1cwt. sulphate of ammonia, and 1½cwt. nitrate

ADVISORY WORK.

During the year under review there has been a noteworthy increase in the number of enquiries dealt with.

The following summary indicates the chief points of interest :—

FRUIT CULTURE.

The enquiries under this head have presented few points of special interest or unusual character. Apart from the treatment of diseases they have been mostly concerned with cultural questions, such as pruning and manuring, the selection of suitable varieties, and the pollination of individual varieties. A case of a local variety of gooseberry throwing outgrowths resembling root excrescences arising from the branches was unusual: and another enquiry relating to the bad cooking qualities of certain apples also proved of some interest.

ECONOMIC MYCOLOGY.

Most specimens sent for examination were of the more common plant diseases. The number of enquiries relating to attacks of the Brown Rot fungi (*Monilia sp.*), on the shoots and branches of various fruit trees indicated probably an unusually widespread and serious attack. Many enquiries relating to an Apple Spot Disease resembling the "Jonathan fruit spot" were received, and a special investigation of the disease is being made. An interesting case of Grenadier apple buds attacked by a species of *Fusarium*, was also investigated. As the result of an enquiry as to the scorching of potatoes following spraying with Bordeaux or Burgundy mixture, a series of trials of various types of Burgundy mixtures has been made. A characteristic leaf scorch of apple trees has been prevalent during the summer of 1915, the cause of which is obscure and still under investigation.

ECONOMIC ENTOMOLOGY.

The enquiries dealt with the following subjects :—

Goat Moth Caterpillar, from Pontllanfraith, Mon.

Gall Mite of Black Currants, from Milverton, Somerset.

Swift Moth Caterpillars in Oats, from Milverton, Somerset.
 Codlin Moth damaging Apples, from Keynsham, Somerset.
 Damage to Pear Leaf, from Crewkerne, Somerset.
 Frit-Fly, from Gloucester, Gloucestershire.
 Stem Eelworm, from Gloucester, Gloucestershire.
 Brown Scale of Currants, from Gloucester, Gloucestershire.
 Woolly Aphis, from Bristol, Gloucestershire.
 Enquiry *re* Napthalin, from Bristol, Gloucestershire.
 Larva attacking Apple Flower, from Budleigh Salterton, Devon.
 Larva attacking Apple Flower, from Bere Alston, Devon.
 Woolly Aphis, from Hereford, Herefordshire.
 Beech Coccus, from Colwall, Worcestershire.

Warnings of the likelihood of a severe attack of Apple Aphis were sent to the *Gardeners' Chronicle*, *Fruit Trades Journal* and to the *Fruit Grower*, and a warning as to the advisability of late sowing of wheat for the avoidance of Gout Fly to the Gloucestershire Farmers' Union.

Throughout the year, whenever possible, visits have been made to fruit growers with the purpose of studying diseases in the field. This year the subject of Reversion in Black Currants has been a special object of enquiry. These visits are of great value in enabling the Advisory Officer to keep in touch with practical horticulture and in suggesting lines for further research.

Special Investigations Undertaken as a Result of Enquiries.

(a) *Frit-Fly Investigation.* In the early part of 1915 a request was forwarded from the Wilts County Council for information about the treatment of Frit-Fly of Oats, a disease which had caused extensive losses in the County during the past few years. As a result, five farms were selected in the county at which experiments could be conducted and where the life history of the insect could be followed.

Each farm was visited twice in the year, and the effect of Napthalin as a deterrant tried.

The Frit-Fly problem is not confined to Wiltshire, and in order to get further light on the subject its distribution will be followed out next year in all the five counties in the administrative area.

A full report of the Wiltshire investigations has been published in the Annual Report for the Wiltshire County Council.

(b) *The Action of Cover Sprays as Winter Washes for Fruit Trees.*—

This subject, originally started in the Session 1912-13 as an Advisory question, has become entirely a Research Problem. It has now been brought to a conclusion with the results published in the Annual Report of the Research Station for 1914.

CIDER AND PERRY MAKING.

The enquiries under this head have been very varied and have covered a wide field. They have been concerned with buildings and equipment required for cider factories, the culture of cider and perry fruit and the selection of vintage varieties, methods of making cider and perry, disorders of those liquors and their treatment, and the utilisation of cider fruit for jam and jelly making.

CHEMISTRY.

The enquiries dealt with during the year may again most conveniently be summarised under the headings—Soil Problems and Miscellaneous Enquiries.

- (a) *Soil Problems.*—Several enquiries with reference to the best system of manuring grass, arable or fruit land have been replied to. In nearly every case these have involved a visit to the farm in question and the partial analysis of two or more samples of soil.

The following cases have involved more extended investigation and analyses :—

- (1) The treatment of greenhouse soil with carbolic acid against root-knot eelworm in tomatoes.
- (2) The examination of several soils in connection with chlorosis of potatoes.
- (3) The examination of soils in connection with difficulty in getting land to grass down satisfactorily.
- (4) Soil analysis in connection with the investigation of a disease of rhubarb.

In addition to the above, at the request of the Sub-Committee on Joint Field Demonstrations of the Provincial Advisory Council, an examination of the soils on which the manurial demonstrations (1914) were carried out in Gloucester, Somerset, and Wiltshire, was undertaken. This involved visits for the collection of samples to 28 farms, and the partial analysis of 62 samples of soil. A detailed Report on the work has been submitted to the Provincial Council.

(b) *Miscellaneous Problems.*

- (1) The value of bracken as litter.
- (2) Analysis of a waste material containing potash.
- (3) Cultivation of flax and buckwheat.
- (4) Value of carbide refuse as manure.
- (5) Value of radio-active manures, etc.
- (6) Analysis of a waste material for feeding value.
- (7) Analysis of a bad specimen of compound feeding cake.
- (8) Advice as to the management of scouring land.
- (9) Advice as to treatment of soil infected with a tomato disease.
- (10) Identification of a weed (*Euphorbia sp.*) and advice as to the desirability of feeding chaff containing considerable quantities of it.

